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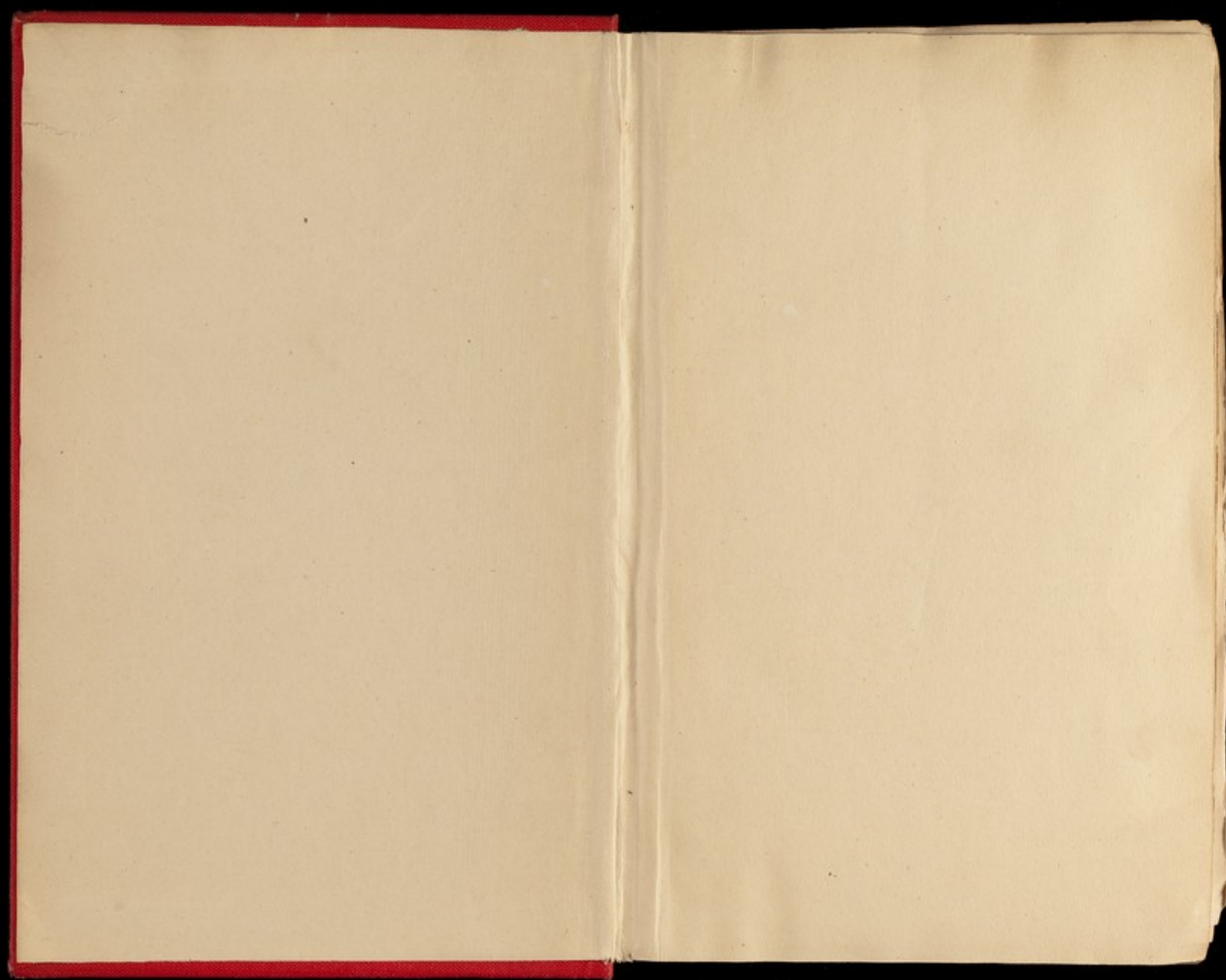
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HINDU SOCIAL LAWS AND HABITS

VIEWED

IN RELATION TO HEALTH.

AN ADDRESS DELIVERED AT THE THIRD ANNIVERSARY OF THE BENGAL
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7

HINDU SOCIAL LAWS AND HABITS

VIEWED

IN RELATION TO HEALTH.

MR. PRESIDENT AND GENTLEMEN,—I purpose to introduce to your notice this evening a subject which I hope will have some interest for the members of this Association. To a medical man, particularly when he is a foreigner, the social customs and habits of the people among whom his lot happens to be cast, are by no means an unprofitable study. To know a disease is to cure it; and as most diseases are local, owing their origin to the peculiar habits, mode of living, and the social indulgences of the patient, it is a duty incumbent upon his medical attendant to make himself familiar with them before he can hope to hit on the right cause of the disease, and to treat it successfully, or at least to alleviate it so far as it may lie within the power of medical knowledge and skill to do. A common idea prevalent among the natives of this country, and that even among the educated and intelligent classes, is that English practitioners are not quite at home in their treatment of native cases, which they think is generally overdone from an imperfect acquaintance with the native constitution, and from a want of skill to adapt to it English Hygiene. Although I do not fully share in this popular belief, yet I cannot altogether reject it as totally undeserving of thought or consideration. On the contrary, the fact that such a notion exists, enhances instead of lessening the obligation under which every medical man, in whatever situation of relative usefulness to the country, ought to feel himself placed, of

knowing for himself, by study and observation, not only the physical and climatic influences which govern health, but those acquired habits, the offsprings of either accident or convention, which grow with one's growth, and strengthen with his strength. It is not possible, in the course of a single paper, to trace *seriatim* one and all the native habits and customs which have reference to health, and therefore cognizable by the medical profession. My object is more to suggest enquiry in this direction, than to read an elaborate discourse upon the subject itself. The results of individual enquiries may be thrown hereafter into a common fund, from which the future student of English medicine in India will derive no small help and aid to successful practice.

The Municipal Committee of 1815 for Calcutta circulated a paper of questions inviting information on sanitary points from those able to afford it. In glancing over the printed questions and replies, my attention was arrested by the singular evasion with which one of the most suggestive queries put forth by the committee was met by nearly all the native gentlemen who were consulted. The question I refer to was, "Do you know any native habits prejudicial to health?" Some of the answers were really amusing; while others, far from enlightening the committee, wilfully "threw dust into their eyes," by openly denying not only all personal knowledge, but by seriously doubting the existence, of any such habits. There was one of the answers which, though brief, was remarkable for its candour. It was of Baboo Kissen Chunder Dutt. He said, "I consider the following native habits most deleterious to health:—1st, Their mode of crowding a house; 2nd, Their sleeping on the ground-floor; 3rd, Their use of unclean water for drink and culinary purposes; 4th, Their treatment of women after delivery." But to one who has paid a careful attention to the subject, and who has studied native life and habits in all their phases, it will appear that the conditions necessary to health are violated in a greater or less degree according to the social position, knowledge, education, profession, employment, taste and means of our countrymen, in more respects than those included in the four general heads given by Baboo Kissen Chunder Dutt. I shall, therefore, follow the natural division given by recent and eminent physiological authorities of the leading conditions essential to health, namely: ventilation, diet, clothing, drink, cleanliness,

exercise, and innocent enjoyments, and consider under each head such peculiarities of native character as are indubitably at variance with the laws of health. My remarks, however, will apply only to Calcutta from which my facts and illustrations have been chiefly drawn.

VENTILATION.

It would be unnecessarily taking up your time to discuss at a place like this the well-known principle, that a constant supply of fresh and pure air is essential to health. We all know that in order to keep the air in its necessary state of purity, it must be continually changing. The change, according to Dr. Parkes, must amount to at least 2,000 cubic feet per hour per head for persons in health, and not less than 3,000 or 4,000 cubic feet or more for sick persons. Less than this will not suffice to keep the air pure, and even this amount is quite the minimum which must be given.

In a Hindoo household, whether for persons sick or in health, the supply of air is regulated on exactly opposite principles. A man in health may have a little fresh air introduced into his room now and then through bye-ways and apertures; but a sick man, never. His room is hermetically sealed. The chinks and holes resulting from unskilful carpentry are carefully filled up with bits of cotton, paper, or rags, so as to make the entry of external air, or the escape of the internal heated air, literally impossible.

An English physician on his first admission into a native sick room feels anything but an agreeable sensation. His warnings against the consequences of a vitiated air in a strictly close room are received with suspicion, and his injunctions to open out the windows of the sick room, to relieve the patient from the effects brought on by breathing a tainted atmosphere, are but reluctantly obeyed. This *hermetically closed box* of a sick room is the result not only of prejudice against fresh air itself, which native mothers have been taught to regard as injurious to their suffering children, but is a precaution and a safeguard against the intrusion of what are called "evil winds" and "malignant spirits."

The windows are closed to keep those winds and all kinds of goblins and hobgoblins out. Every sickness of a child is attributed to the touch of some "evil wind," or of some goblin's breath, and while the doctor is exhausting his *vade mecum*, and inditing endless recipes for the cure of his patient, the ignorant Hindoo mother trusts for the recovery of her child, not so much in the physician's skill, as in the efficacy of the *mantras* which the priest is set to chant daily, to counteract and neutralize the influence of the "evil wind." Thus, it will be observed, that ignorance of the properties of air and superstitious fears are the two powerful influences which an English practitioner will have to combat before he can hope to get a native sick-room well ventilated; and as free ventilation in a sick room, subject of course to certain degrees of temperature, is an important remedial agent, his successful treatment of a case will mostly depend upon his ability to impress the relatives of his patient with its importance.

In ordinary apartments, the arrangements for the induction of pure air are likewise very imperfect. In most rooms in which human beings live or are assembled for a time, the air unavoidably becomes considerably vitiated. The carbonic acid gas expired by the lungs, if free to mingle with the air at large, will do no harm; but if breathed out into a close room, it will render the air unfit for being again breathed, for in such a situation, there cannot be a sufficiently ready or copious supply of oxygen to make up for that which has been consumed, and the carbonic acid gas will be constantly accumulating. "An extreme instance of this case was that of the celebrated 'Black Hole' of Calcutta, where 146 persons were confined for a night in a room of eighteen feet square with two small windows. Here the oxygen, scarcely sufficient for the healthy supply of one person, was called upon to support a large number. The unfortunate prisoners found themselves in a state of unheard-of suffering, and in the morning all were dead but twenty-three, some of whom afterwards sunk under putrid fever brought on by breathing so long a tainted atmosphere."^{*}

I will not go so far as to say that every Hindu house is a little black hole within itself; but it cannot be denied that it

^{*} Chambers' *Information for the People*. Chapter on Health.

is crowded to an extent not compatible with the laws of sanitation, the inmates scarcely occupying a space of more than 400 to 500 cubic feet of air. These family gatherings may be a commendable trait in the native character on account of their tendency to promote family attachments, love and regard for distant relatives; but speaking from a sanitary point of view, the over-crowding of houses is the source of innumerable diseases which in their attack take at once a virulent shape, and are not easily overcome. Considering the size and dimensions of the generality of native houses, they are already ill calculated to afford shelter to the number of people generally found dwelling within them. But when we look to their peculiarity of construction and means of ventilation, the evil seems to be aggravated a hundred-fold. A native house has generally two divisions, namely, the outer and the inner apartments; the former occupy the greater space of the two, consisting of sitting and reception rooms, exclusively for the male members of the household, a hall or *dalan* for the celebration of *poojaks* and festivals, and an open court-yard for *nautches* and other entertainments. These apartments are more or less commodious, are more or less airy, according to the means, taste, and inclinations of the owner of the household. But further on from these apartments, and situated on the back of the *dalan*, are the inner apartments, the *untappoor* or the *zenana*, into which are consigned the females of a Bengalee household,—our mothers and our wives, our daughters and our sisters,—in fact all the dearest partners and associates of our social existence. The construction of these apartments is always the subject of jealous scrupulousness. There must be as few windows as possible, and where they cannot be altogether avoided, care is taken that they do not open on a public street or on a neighbour's house, thereby keeping out the sunshine and the wind of heaven as much as possible. But it is not to be supposed that these apartments are exclusively allotted to women. The male members of the household, after enjoying up to a certain hour of night the company of their friends, and what is dearer than all,—their hookah,—retire to seek in these apartments the solace and repose which a hot bed, a saturated atmosphere, and a dingy, smoky room can afford. Sleep which is "Nature's sweet restorer," instead of imparting freshness and vigour to one's spirits, brings on lassitude and enervation, which are the predisposing causes of sickness. Cooking-rooms without proper chimneys

and smoky outlets generally form part of these dwelling apartments, in addition to which source of mischief is the *Astakoor*, or place for throwing the refuse of the cooking-house. It may be easy to imagine the noxious quality imparted to the atmosphere by stagnant water and decaying vegetable and animal matter. It is now generally acknowledged that this noxious quality is in reality a subtle poison, which acts on the human system through the medium of the lungs, producing fevers and other epidemics. The miasmata or exhalations from these cesspools, mixed with intolerable odours, nauseate the most healthy stomach, and derange the most perfect constitution. There are also the odious privy houses, one sufficing for a whole family. They are seldom or never cleared, and are a perennial source of disease and unhealthiness. Some with a view to economy, sink wells underneath their privies, which transmit the filth of one generation to another like an heirloom. It is now also generally known that tanks and collections of water of every kind are dangerous beneath or near a house, because unless their contents be constantly in a state of change, which is rarely the case, their tendency is to send up exhalations of a noxious kind. But to a native house, contiguous to the female apartments, is generally attached a tank in which the women perform their ablutions, wash their cooking utensils, and the water of which they use for culinary and domestic purposes. It is, however, nothing better than a kind of mill-pond into which every kind of refuse is thrown or is allowed to discharge itself, the putrid matter thus collected not being cleared out once for a long series of years, no one dreaming of any harm from it. And yet the noxious air diffused by these means tends to the most fatal effects. The progress of knowledge and the appreciation of sanitary laws are however making a great change in the construction and fitness of native houses. Greater attention is now being paid to ventilation and cleanliness in the new houses which we see are springing up on all sides; but there are yet in the midst of our "City of Palaces," innumerable old-fashioned pre-historic mansions which stand firm upon their bases, though it would have been no loss to the world if the cyclone had swept them bodily into the Bay.

Diet.

Under this head, I have but few remarks to offer, as the food of the generality of the natives of this country is of a

kind which is at the same time nutritious and wholesome, though not quite unexceptionable. The ordinary food of the natives of this country is rice. What potatoes are to the Irishman, rice is to the Bengalee. Those who are very poor eat it with herbs gathered in some fields. The middling ranks eat it with split peas, greens, fish, &c. The rich add a number of other things such as boiled fish, acids, pungent spices, &c. They also fry in clarified butter, potatoes, cabbages, coconuts, pumpkins, cucumbers, &c. There are certain sects of Hindus who live exclusively on vegetables, as the Vaishnubs, to whom all fish, flesh and fowl is forbidden food. But with regard to existing restrictions on the use of animal food, Mr. Ward mentions a fact which cannot but excite surprise and indignation among our orthodox countrymen. "Nothing," says he, "can exceed the abhorrence expressed by the Hindus at the idea of killing cows and eating beef; and yet the Veda itself commands the slaughter of cows for sacrifice, and several Poorans relate, that at a sacrifice offered by Vishwamitra, the Brahmins devoured 10,000 cows which had been offered in sacrifice." It may be an interesting enquiry in the abstract as to whether our ancestors were actually beef-eaters; but it is not to our present purpose. All that I can say is that if ever they were, the circumstances which brought about a change and a revolution in men's ideas and feelings regarding cow-flesh fully justified the conclusion at which they arrived; for in a hot climate like this, the free and liberal use of all kinds of stimulating animal food ought to be avoided. Milk itself is a very nutritious food, and, excepting the poor, is used largely by all classes of Hindus. Hindu children are chiefly reared on milk, the average consumption per day being a seer or a seer and a half for every child between 3 and 4 years old. Adults also consume about the same quantity in addition to their ordinary food. Ghee or clarified butter is also an article of immense consumption among the natives of Bengal. It is not only used largely by the rich in their curries, but is eaten raw with boiled rice.

The Hindu Shastras direct that Brahmins shall eat at two o'clock in the day, and again at one in the midnight; but a variety of circumstances have produced irregular habits; these, however, are still considered as the appointed hours for eating by those Brahmins who study the Shastras, who make *poojahs*, and who feed upon the bounty of Soodras

and rich men. But Brahmins and all classes who are in the service of Government, eat once at nine o'clock in the morning, and again at about the same hour at night. These hours, however, are altogether disregarded on holidays, and on occasions of festivity. When a native gentleman invites his friends and relatives to a dinner at his house during the day-time, the hour mentioned is 12 o'clock, or noon-day, but the guests begin to drop in after 1 o'clock, and the dinner is not eaten before 4. These late dinners, therefore, cannot but be attended with the most injurious effects on the health of those who eat them. A Bengalee dinner is quite a different thing from an English dinner. In the former punctuality can never be looked for or enforced, and indeed how can it, when the number of guests may vary between a few hundred and a few thousand souls? Ward mentions that at the house of a Rajah at particular festivals, sometimes as many as 20,000 Brahmins were feasted. The same authority says, that at a *shraud* performed for his mother by Mr. Hasting's dewan, Gunga Gobind Singh (of Jamookandee, near Moorsshedabad) the founder of the house to which our illustrious citizen Rajah Pertaup Chunder Singh Bahadoor belongs, six hundred thousand Brahmins were assembled at one feast, and dismissed with presents. These monster dinners are rare in these days, but even the little ones that we have, are causes of innumerable diseases which prevail among the Hindus of all orders and grades. The Brahmins however are a particularly dinner-loving people; certain classes among them are professional eaters, who literally train up their children to dinner-eating. These dinner-mongers, it is said, glut themselves in a most reckless manner, and then fall victims to their most unnatural craving for a surfeit. The Hindu women, particularly widows, are given much to fasting. The high-caste widows regularly fast for two days in the month, when not even a drop of water passes their lips. They take but one meal in 24 hours, and even that they deny themselves on every 11th day of the moon, and on the occasion of almost every important Hindoo festival. It is to be expected that this course of abstemiousness and fasting would tend to fatal effects among them, but the contrary appears to be the truth; for Hindu widows appear to enjoy comparatively greater longevity and freedom from disease than most other members of the community.

The Hindus are a notorious people for eating sweetmeats. They consume no end of *sundess* and *metaye*, which consist more of sugar and less of nutritive matter. Children as soon as they are weaned find in sweetmeats a ready substitute for their mother's milk. They eat them voraciously, and in the end suffer for it. It is no wonder that Bengalee children are so stunted in their growth, so constantly sick, and so easily die out. Most diseases of children are owing to improper diet. If they are not allowed to eat sweetmeats they will take to acids, to tamarinds, sour mangoes and plums, all of which have a tendency to impede digestion and a healthy action of the stomach. Adults also have a predilection for sweetmeats such as have little or no nutritious properties. In fact, it is my strong conviction that so long as the Bengalees are a sweetmeat-eating people, they will never become an improved race in physique. Their diminutive stature, their want of vitality and energy, may be all traced to inadequate nourishment. The chief requisite of health is a sufficiency of nutritious food. The organic constitution of man, like that of all animals, depends upon the principle of a continual waste of substance supplied by continual nutrition. Such nutrition may be obtained from a wholesome dietary, composed of animal and vegetable substances. Climate, however, has a remarkable effect in modifying the rule as to the mixture and amount of animal and vegetable food. The former has most of a stimulating quality, and this quality is greater in beef and flesh in general. Now, the inhabitants of tropical countries are, in their ordinary condition, least in need of a stimulus. Hence, a simple diet of rice and fish curry may be found sufficient for them. But whatsoever vegetable substances a man in a hot climate may choose to live upon, he must not lose sight of the first principle in physiology, that "the continual waste of substance should be supplied by continual nutrition." In the climate of India, if flesh meat is to be dispensed with, its place may be well supplied by milk, rice, wheat-flour, green and dry peas, which supply all the nutritive requirements of the human system. Wheat-flour has more nutritive properties than the common *balau* rice of Bengal. Hence it is that the people of the North-Western Provinces, who live chiefly upon it, are a more robust and healthy race of men than the rice-fed people of the Gangetic Valley. I have drawn up for ready reference a comparative table shewing the principal articles of a native dietary, in their relative proportions of

flesh-forming and heat-giving qualities which, I hope, may be useful to my countrymen in regulating their choice of food.*

CLOTHING.

This division of my subject is easily disposed of. The primitive dress of the natives, in which there are neither buttons, springs, nor pins, is happily suited to the climate of this country, and produces a very graceful effect. Over their loins they fold a cloth, which almost covers their legs, hanging down to the tops of the shoes. The upper garment is a loose piece of fine white cloth, without seam from top to bottom, thrown over the shoulders, and, except the head, neck, and arms, covering the whole body. The head is always uncovered unless the heat or cold constrain the person to draw his upper garment over it like a hood. This description of native dress does not, perhaps, gentlemen, tally with what you see now-a-days. Educated Bengal puts on caps and turbans, wears pantaloons and *payjamas*, and if he does not dabble in an English coat, has at least a substitute for it in what is called a *chapkan*. But all this, gentlemen, is an imitation of the European or the Mussulman dress. The primitive Hindu dress consists of a *dhotee* and a *chadar*, such as Pundit Ishwar Chundra Vydiyasagara still delights to put on. In the hot weather, a cotton *chadar* was quite sufficient. In the winter it was simply exchanged for a woollen sheet or a Cashmere shawl. The use of jackets or tailor-made cloth was unknown. Much less were stockings in vogue. But the force of habit and association is such that when Sir Philip Francis first landed in India with his coadjutors in office, he concluded that Hastings must have governed most tyrannically over the natives, as they had not even stockings on their legs, which in his opinion denoted abject poverty and positive distress. Clothing, however, must be regarded in the light of a protection from the extremes of heat and cold, so that the body may perform its functions healthfully and without obstruction. "Keeping this view," says an eminent physiologist, "and also bearing in mind the nature and action of the human skin, it is easy to deduce that clothing should be of such a nature as not to impede the necessary escape of perspirable matter, but to suffer it to pass through

* See Appendix A.

its texture; that it should be of such a non-conducting quality as to confine the heat generated by the blood sufficiently to preserve the activity of the nervous system; and that by its lightness, softness, and pliancy, it should permit the free motion of the limbs." The primitive dresses of the Hindus are admirably suited to a perennially hot climate. But in Bengal we experience such vicissitudes of season, that the loose upper flowing garment is not a sufficient protection against all seasons and all weathers. In the winter, an inner garment next to the skin, and closely fitting the body, is felt to be necessary. Cotton being inferior in its non-conducting qualities to wool, is not a suitable dress for winter. There can be no doubt that flannel is by much the best article for being worn next the skin, as it tends to preserve a more steady equilibrium in our bodies under alternations of heat and cold. In a tropical country like this, however, a loose flowing garment is to be preferred, as offering a free exercise to the limbs, to the precise and the more closely fitting clothing of modern European nations. In this hall, however, some years ago, an opinion was advanced containing an advice to the natives of this country to discard their Oriental garb, and to don the scientific costume of Europe. This opinion, however, was confronted by the *Calcutta Review* of the day in so able a manner that I cannot resist the temptation of quoting its words:—

"All the innovations which distempered fancy and perverted taste could possibly select, this is without exception the worst, and we sincerely hope will never be accomplished. It is scarcely possible to imagine anything more ungraceful, unbecoming, and destructive of freedom of movement, as well as symmetry of form than the modern European dress, from the unsightly head-gear, for which a quaint quasi-physiological reason was advanced, much at variance with the principle of construction of patent ventilating gossamers, to the various other articles of habilitment, in which the Caucasian races of the 19th century are encased. It would not be difficult to find adequate protection for all the important organs of the body from among the strictly Eastern garments worn in different parts of Hindustan, without resorting to the unsuitable and inappropriate devices of the Billy Buttons of the Western Hemisphere.

"Young Bengal is already sufficiently ridiculous in straps and tights. He would out-bloomer the most outrageous of the tasteless innovators of recent times, were the predilection for tail-coats and alarming waistcoats to become epidemic, and the rising generation of Dutts and Sens, like the small tiger in *Punch*, to break out all over in buttons."

The dress of educated natives, borrowed partly from the Mahomedan costume and made up partly from their own, is quite suited to the climate under which they live, to their business avocations, and their conventional usages. It is just as scientifically adapted to the inhabitants of this tropical country, as the European costume is to the men living in the colder regions of the north.

The dress of the women of Bengal consists of only one long piece of cloth, which, wrapped round the loins, comes over the shoulder, and generally over the head as a hood. The same garment serves equally for summer and winter, and is, therefore, not a sufficient protection for the body in all seasons. It seems remarkable that, while the men have improved their own dress and adapted it to the changes and vicissitudes of season and weather, the women of the country should show no signs of improvement in their dress. The reason is obvious. Living as they do in seclusion, they are conservative to the backbone. A Bengalee lady will not put on a new form of garment, because she had never done it before. To be able to induce her to clothe herself sufficiently and elegantly, the pressure must be brought from without. The male guardians of the household must induce her to feel her position as a member of society and as the companion and help-mate of man. Her duties as a mother are particularly onerous and responsible—the health of her children depends upon her own. If she is careless about her dress, if she unnecessarily exposes herself to cold, if she does not keep herself dry under a saturated atmosphere, and allow a free perspiration to relieve her from the effects of damp, her constitution will naturally be enfeebled, and she will become the subject of a thousand distempers, which, through her, will tell upon the health of her children. That our women are insufficiently clad in all seasons is, therefore, a subject well worthy the consideration of all educated natives. It does not fall within the scope of my present address to discuss the kind of dress which should best fit our women, "affording

adequate protection for all the organs of the body," at the same time leaving her free to perform and go through the whole round of social duties which devolve upon her. The question must be left to the good taste and good sense of that portion of our community who are now interested in the advancement of the social status of our country-women.

WATER.

Water is one of the primary wants of human life, no less essential than air and food. Whether for dietetic or domestic purposes, it has always been regarded by natives in all parts of India as a source of endless convenience. Its importance and uses are so well recognized that a strong religious interest has always been attached to its means of supply. To the principal rivers of Hindustan, a divine origin is ascribed by the Shastras. Bathing in them removes all sin. From the Himalayas descend the Gunga, Saraswattee, Sindho, Chunderbhaga, Yumoon, Oiravatee, Gomutte, Gundakee, Kushikee, Uvantee, and several others,—all of which have a sacred interest in the eyes of the Hindus: but none approaching in holiness to the Gunga or Bhageerutty, the waters of which purify all sin, and send the soul up to heaven. One of the common forms of prayer muttered by the Brahmins while bathing in the river is, "O Gunga; thou art the door of heaven; thou art the watery image of religion; thou art the garland round the head of Shiva; the craw fish in thee are happy, while a king at a distance from thee is miserable." Pure or impure, clean or muddy, stinking or odoriferous, its water, says the Shastras, may be drunk with everlasting benefit to the human soul. A man should not scruple if he found any filth mixed with his drinking water, when that water was drawn from the Bhageerutty, but separate the filth from the water, and drink the latter with a light and gladsome heart. Tank water, or water from artificial reservoirs, is not pure or holy in the meaning of the Shastras, and is, therefore, not usable in religious rights and ceremonies. It may be used for drinking and other domestic purposes, where Gunga water is not available, but the greatest strictness is enjoined by the Shastras for keeping it clear of all impurities. Menu says that a man should not cast into such waters "either urine or ordure, or saliva, or cloth, or any other things soiled with impurity, nor blood, nor any other kinds of poison." Bearing in mind the sanctity ascribed

by the Hindu religion to the water of the Ganges, it is not difficult to understand why the Hindus of Calcutta prefer it to tank water, or rain water, for drinking purposes. Some Baboos of Calcutta do, indeed, get their supply of water from their garden tanks, but their number is small. The largest section of the community, and Hindu women in particular, drink nothing but Ganges water. The purity and impurity of that water has, therefore, greatly to do with the health of the native population of Calcutta. That organic and other impurities in water are prejudicial to health, is not a mere matter of conjecture or surmise, but an established principle founded upon experiment and scientific investigation. At a Meeting of the Society of Arts in London, in 1865, the following striking facts were adduced, which conclusively showed that organic matter in a putrifying state is the worst form of contamination that water can have, and is a prolific source of disease and mortality. About the time of the last epidemic of cholera in London, in 1853 and 1854, there were two rival Water Companies, the one supplying nearly 25,000 houses, and the other nearly 40,000 houses, to an entire population of about half a million. This vast population was living, so far as could be judged, in all respects alike, except as to the one difference of their water supply only. And that difference was that one Company drew its water from high up the Thames, where it was of comparative excellence, while the other drew its water from low down the river, where it was profusely contaminated with town drainage. In the year mentioned, among the population alluded to, there were more than 4,000 deaths from cholera. An enquiry was made, house by house, as to those deaths, and the result showed that in the one set of houses the mortality per 10,000 of the population was 37, while in the other set of houses it was 130, that is to say, the cholera death rate was 3½ times as great in the one set as in the other. Going back to the preceding epidemic of cholera of 1848-49, it was found that the mortality from cholera was about equal in the two groups of houses. There could, therefore, be no doubt that the difference between the two waters in the former case, was the cause of the excessive mortality with one set of houses as compared with the other.

Perfectly pure water is hardly to be found. The impurities exist in one or two ways, either floating, suspended in the form

of solid particles, or in a state of solution. When running water comes upon a loose bottom, it carries the finer particles of sand and clay along with it, and the quicker it flows, the larger the pieces it can keep aloft. When the water comes into a position of perfect stillness, the matter thus floated gradually sinks to the bottom, the heaviest first, and the others in succession. The common practice in India of separating mud and other impurities from water is by putting in a piece of alum or *nermales* (*Strychnos Potatorum*), which seems to act, by the property it has of coagulating the organic substances, and of causing the others to adhere as dyes to such solid matters as may happen to be in the water. The great bulk of solid matter held in solution in ordinary waters consists of salts; that is, combinations of acids with saline bases. The saline bases are chiefly soda, potash, lime, and magnesia. The most common of these matters is carbonate of lime or common chalk. Carbonate of lime alone is insoluble in water, but it is dissolved when water contains carbonic acid. Another substance of some importance is the chloride of sodium, or common salt, the existence of which in waters makes them unfit for drinking purposes. The water of the Ganges, from its proximity to the sea, contains a large quantity of salt. During some months of the year, when the tides are in their greatest force, the impregnation of saline matter is so perceptible that the water cannot literally be touched with the lips, yet this water is used for drinking purposes throughout all seasons of the year, which cannot but have a most deleterious effect on the health of the native population of Calcutta. And as the water is most salted during the months of the cholera epidemic, it is most natural to infer that this great scourge of Bengal has its origin, in a great measure, if not entirely, in river water, which enters so largely into the native constitution. From a careful analysis prepared by Dr. Macnamara of the river water at four principal points, namely, Fort Point, Cossipore, Pultaghât, and Chinsurah, the following result is obtained, showing the proportion of the saline ingredients in a gallon of 70,000 grains during the cholera months, namely, February, March, April and May, when the water is in its most foul state.

* Soluble Salts.	Febry.	March.	April.	May.
Fort Point ...	.....	.....	.....	59.9
Cossipore ...	1.8	7.3	29.4	38.7
Pultaghât ...	1.86	1.93	2.7	5.3
Chinsurah ...	2.2	2.1	2.2	2.4

Speaking of the water from the Cossipore Point, which is about one mile above the Bag Bazaar Canal Bridge, Dr. Macnamara observes, that the water during March, April, May, and June, is largely intermixed with the saline matters of the sea water and the sewerage of Calcutta, and during that time is unfit for human consumption. "The cholera months of February, March, April and May," he remarks a little further on in his Report, "are not otherwise the most sickly months of the year in Calcutta. Must we then not look for some special cause exerting itself in the comparatively healthy months in increasing the number of cholera cases, and do we not find one that will account for the increase in the contaminated state of this water supply at the time?"

But the most injurious of all impurities is the contamination of water by vegetable and animal substances. These are of two kinds—*living* and *dead*. Living organic matter is contained in running streams in large quantities, either as plants or animals, of which some forms are visible to the naked eye, while innumerable others are disclosed by the microscope. But these are comparatively more harmless than dead organic matter which exists in a state of putrid decomposition, and in minute forms of life bred among such impurities. The most obvious and abundant source of this class of ingredients is the sewerage and refuse of towns.

* For a fuller analysis of all the ingredients of river water during the months above-mentioned, refer to Appendix B.

Though we may not know the precise effects of these impurities on the animal system, the single fact of their rendering the water repulsive to the taste and nauseous to the stomach, would be sufficient to prove their unwholesomeness. The practice of letting the sewerage and refuse of Calcutta into the Ganges, cannot, therefore, be too strongly condemned. The water, with the influence of the tides, not only becomes disagreeable to the senses, but is literally impregnated with particles of ordure and other kinds of filth, which make it quite unfit for bathing, far less for drinking purposes. I am able to say, from a very reliable source, that 180 tons of nightsoil are thrown daily into the Ganges at Jackson's Ghaut, which contaminates the water as high up as the Cossipore point. Seeing that the people will drink nothing but river water, it is an act of gross inhumanity on the part of the conservancy managers of the city to persist in their course of emptying into it the whole nightsoil of the town. It is a point which cannot be too strongly urged upon the attention of the authorities, involving as it does the question of the health of between 3 to 4 hundred thousands of souls. River water at particular seasons of the year, particularly in the month of January, becomes clear and apparently free from impurities. Those natives who are able to afford it, keep a store of such water in their houses against unfavourable seasons when the water is most muddy and saltish. But the bulk of the people live on their every-day supply of fresh water, and are thus exposed to the dangerous tendency of its contamination during periods of epidemic cholera.

For culinary and other purposes, the water used by the natives is chiefly drawn from wells and tanks. But the condition of most tanks in the native part of the town is miserable; and their water generally, from the decomposition of animal and vegetable substances, becomes so unwholesome that we cannot safely cook our food with it. We sometimes receive premonitions of their unwholesomeness from the offensive taste and smell which they impart to our cooked food. It is, therefore, of the last importance that there should be interspersed in the native part of the town a sufficient number of good tanks to be able to meet the water supply of the entire population. This subject, however, cannot be summarily disposed of. It should engage the serious attention of medical men and all interested in the promotion of health among the native inhabitants of Calcutta.

CLEANLINESS.

Cleanliness is another important requisite for the preservation of health. The Hindus are in some respects a very cleanly people, superior to many ancient nations, and even many modern ones who stand high in the scale of civilization. The Hindu Shastras are replete with laws for the purification of the body. The liberal use enjoined by them of water for purposes of ablution, is sometimes carried to a vexatious degree. A man cannot stir a foot abroad, cannot touch with his hand any part of his body, cannot even sneeze, without being ordained to the necessity of performing some kind of ablution or other. According to Menu, oily exudations and fluids, blood, feces, ear-wax, nail-pairings, phlegm, tears, concretions on the eyes, and sweat, are all impurities of the human frame requiring for their purification an abundant use of water, as recommended by the Shastras. In fact, the impurities of bodies can only be cleansed by water. Besides these constant washings of the face, hands, and feet, and constant sprinkling of water on the human body, total immersion in water at least once a day, before a man says his prayers or takes his food, is strongly enjoined as a religious duty. The effect of such baths from a medical point of view cannot but be highly beneficial to the human system. The use of unclean garments is prohibited by the Shastras. A man is not considered fit for religious or sacrificial duties or competent to attend to any of the usual domestic avocations, until he has put on a clean dress. His domestic appurtenances are also regarded as unclean, until they have undergone some process of washing or purification. The house in which he lives must be rubbed, brushed, and smeared with cow-dung before the occupations of the household could be resumed for the day. His cooking utensils, whether of copper, iron, brass, pewter, tin, or lead, should be fitly cleansed with ashes, with acids, or with water, before they could be again used. The land attached to his house enclosed or unenclosed, is required to be cleansed either by smearing with cow-dung, by sprinkling or by scraping it. It would be tedious to enter in detail into all the social laws of the Hindus for personal and household purification. Those already enumerated abundantly testify to the habits of cleanliness practised by the Hindus from time immemorial in accordance with the letter and spirit of the Shastras. But how far these habits and laws are consonant to modern practical hygiene is a question which should fitly engage the attention of medical

men and sanitary reformers. Ablution is undoubtedly one of the best means of attaining personal cleanliness. Its great end is to keep the skin in a fit state for its peculiar and necessary functions, the most important among them being that of perspiration. The human system is subject to a watery secretion, which is sent up through the skin by channels imperceptibly minute and wonderfully numerous. The promotion of the free egress of the fluid is of the utmost importance to health, for when it is suppressed, disease is ready to fall upon some of the organs concerned in the discharge of the water.

The fluid is composed, besides water, of certain salts and animal matters which being solid, do not pass away in vapour, as does the watery part of the compound, but rest on the surface where they have been discharged. If not removed by some artificial means, they form a layer of hard stuff, and unavoidably impede the current of perspiration. Frequent ablution of the body prevents this or any other extraneous matter from accumulating on the surface of the skin, and, by clearing the pores, promotes the free exudation of perspirable matter, to the great relief of the human system.

The native practice of anointing the skin with oily matters before the bath, may be considered as a check to perspiration. But in a hot climate like this, oily anointment has the effect of cooling and softening the skin, and while it does not altogether suspend perspiration, it prevents a copious flow of the watery compound, which cannot but produce exhaustion and prostration of the nervous system. The oil is besides rubbed off in the process of ablution, and afterwards by dry cloths. It is only the ignorant and the poorer classes who anoint themselves profusely with mustard oil, take a dip, and, without letting themselves dry, attend to their avocations, carrying a thick coating of oily substance on their skin. Frequent change of the clothing next to the skin is also a great aid to cleanliness, and may partly be esteemed as a substitute for bathing, seeing that the clothes absorb much of the impurities, and when changed may be said to carry them off. The Hindus have an excellent law on this head. Menu says, "Let no priest who keeps house and is able to procure food, ever waste himself with hunger, nor when he has any substance, let him wear old and sordid clothes." The rich and the well-to-do people change their dress at least twice a day, putting on at every time a fresh suit of clothes whitened by the washerman. The duties of the washerman are even

prescribed by Menu. "Let a washerman wash the clothes of his employers by little and little, or piece by piece, and not hastily, on a smooth board of salmali wood. Let him never mix the clothes of one person with the clothes of another, nor suffer any but the owner to wear them." The middling ranks who cannot afford to have their clothes whitened daily by the washerman, have them washed at home in tank or well water, and they wear them after drying them in the sun. The poorest classes and mendicants who have scarcely any tattered rags to put on to their backs, cannot help wearing sordid clothes, but they still soak them in water once a day, putting them on while wet, and suffering them to be dried on their bodies by the sun and their own animal heat.

The Hindu practice of household cleanliness is rather a strange compound of anomalies, for while they will have their rooms cleansed by sweeping, by scraping, and by sprinkling of water, for more than once a day, they will suffer the sweepings, and the scrapings, and the refuse of the house to accumulate, and to putrify under their noses, contaminating the very air they breathe. This may, however, proceed from the imperfect knowledge of the properties of air and malarious matter. The Hindus are very particular about the cleanliness of their cooking-rooms, which they will have every day smeared with cow-dung, it being according to the Shastras one of the several pure things vital to cleanliness. Cow-dung has undoubtedly deodorising properties, and is now used under the sanction of medical authorities for cleaning jails and other public buildings in the Mofussil.

The Hindu idea of cleanliness, however, is associated with religion. Their ablutions, their baths, their change of dress, their household purification, are all parts of a religious system having directly little or no reference to sanitary or hygienic laws. By this I do not mean to assert that the Hindus were ignorant of the laws of public health. On the contrary, their hygeology or hygiene is of a very detailed description, descending to minutiae or trifles unthought of in the systems of other nations. Only in a tropical country like this, the causes of disease are so active and numerous in their operation, as to demand the aid of religion to assist in saving mankind from the ravages that would be caused by neglect or inattention to them. Dr. Mouat, in his essay on Hindu Medicine, (*Calcutta Review*, No. 16), very justly observes,

"that the personal duties, including all operations connected with the toilet and dress, as well as the subject of duties generally, appear to have been carefully inculcated, and enjoined in many respects in a clear and sensible manner, admirably adapted to the moral and social circumstances of the people. Habits of cleanliness and the frequent use of baths and anointing were among the religious duties of respectable individuals, and correctly deemed essential for the preservation of health."

Dr. Chevers, in his two lectures on the laws of public health, delivered before the Bethune Society, likewise impressed upon his hearers that personal filth was by no means a characteristic of the natives of Hindustan; generally the lowest, and those sunk in extreme poverty, were the only people among natives who were essentially unclean.

EXERCISE AND SOCIAL ENJOYMENTS.

Although exercise and innocent enjoyments are another important requisite for the preservation of health, yet the laws of Menu present a perfect blank in this respect. In practice also, all kinds of manly exercise are avoided; walking, running, fencing, dancing, riding, rowing, skating or swimming, as an exercise for the body or the limbs, is unknown or seldom, if ever, had recourse to, from fear of accidents. "The most superficial observer of Bengalee manners must know," says a writer in the *Calcutta Review* (*Vide* No. 30 on 'Bengalee Games and Amusements') "that their games and sports are for the most part sedentary. The amusements of a numerous people that do not supply the British army with a single sepoy, cannot be expected to bear a military character. The Bengalee is certainly the least pugnacious animal in the world. The gods did not make him warlike. Possessed of lax nerves, of a feeble body, and of a timid soul, nature has not meant him to handle a gun, or wield a sword. Unlike the horse mentioned in the book of Job that paweth in the valley, and rejoiceth in his strength; who goeth to meet the armed men, mocketh at fear, and is not frightened; who smelleth the battle afar off, the thunder of the captains and the mighty; the Bengalee quietly folds up his arms, smokes his *hookah*, and carefully barricades his door at the approach of a red coat. Placed as the Bengalee is under the

"fervours of a tropical sun, and indisposed to frequent locomotion, we cannot expect him to be proficient in field sports; his maxim being 'that walking is better than running, standing than walking, sitting than standing' and lying down best of all; it would be preposterous to expect him to excel in any sports requiring manly activity. Gentle in his manners, idle in his habits, timid in his dispositions, unenterprising in his thoughts, and slow in his motions, all his amusements and games must be for the most part sedentary.

"The chess, the *pasha* and cards constitute the whole circle of the games of the largest portion of the intelligent and sober part of the Hindu community. They are played in the halls of the rich, the *chandimandab* of the middling classes, and under the shades of trees. The Bengalees are a very sociable and pleasure loving people. Gregariousness is one of the prominent features of their national character. In every village, the people assemble together in separate parties subsequent to their afternoon nap for purposes of recreation and interesting talk; we do not here speak of the lower orders of the people, but of the gentry of Bengal. In the cool of the evening, parties of respectable natives may be not unfrequently seen sitting under the umbrageous *Bukul*, and amusing themselves with chess, *pasha* or cards. Laying aside for a season the pride of wealth and even the rigorous distinction of caste, Brahmins and Soodras may be seen mingling together for recreation; the noisy vociferations and the loud laugh betoken a scene of merriment and joy. The *hookah*, a necessary furniture of a Bengalee meeting place, is ever and anon by its fragrant volleys ministering to the refreshment of the assembly, while the plaudits of the successful player rise higher than the curling smoke issuing from the coconut vessel. The games over, they separate for a short time, and when the shades of evening thicken around them, re-assemble within doors, and amuse themselves again with music and cards."

Turning to the lower orders of the people and the peasantry of Bengal, we find that some of their sports require considerable muscular activity, agility and locomotion. Unlike the indolent and the lazy people of the higher classes, they have their games and gymnastics which call into action the muscles of the higher and lower extremities, improve the carriage of the

body, develop the organs, and impart a general tone of healthiness to the whole system. The most important among their active sports is the *hadu gadu* or *koppatee*. For a description of the game I must refer my hearers to the article from which I have already quoted, in the *Calcutta Review*.

Archery and sling are common amusements among the herdsmen of Bengal. They may be seen in the fields vieing with one another in throwing stones to the greatest distance by means of their rudely made slings. *Danda-gulee* is the bat and ball of the Bengalees. The *danda* is a stout stick two feet long, and the *gulee* stouter still of the size of half a span. The sport resembles the bat and ball in so many respects, that it is scarcely necessary to describe it. It is chiefly played by boys. Young men and old men sometimes join the play by way of diversion, particularly on the day sacred to Saraswattee or the goddess of wisdom.

"Wrestling," says the *Calcutta Reviewer* to whom I have just referred you "is by no means uncommon among the peasantry of Bengal. In all seasons, but especially in the winter, they wrestle together on the outskirts of a village. The stadium of the Bengalee wrestlers is usually a small space of ground under a tree, whither the candidates repair in the mornings or evenings. Unlike the athletic in the Olympic stadium who wrestled in the eye of assembled Greece, and had their names heralded forth throughout the length and breadth of the glorious land, the wrestlers of Bengal are unobserved and unapplauded, except by their rustic comrades. The wrestling over, the simple peasants throw themselves into an adjacent tank or brook, wash their soiled bodies, and not unfrequently crown the amusements of the day with a swimming match."

I shall bring this division of my subject to a close by simply observing that the indolent and sedentary habits of the higher classes of natives contrasted with the active sports and manly exercises of the peasantry of Bengal, afford sufficient explanation of the weak, flabby and shrunken bodily frames of the former, while the latter are in the enjoyment of a robust constitution with almost perfect immunity from the various forms of disease incident to the climate, the soil, the air and water of Lower Bengal.

Gentlemen,—Having noticed the chief requisites for the preservation of health under the leading conditions of ventilation, diet, clothing, drink, cleanliness, exercise and the social enjoyments, I shall now pass rapidly under review some of the more prominent evils peculiar to the Hindu social system which have their origin either in conventional usage, in a code of ethics belonging to a remote age, in domestic habits and manners acquired under peculiar influences.

The treatment of women before and after delivery, is a matter of great importance in a medical point of view. There can be no question that respectable Hindus as well as the lower orders of people treat a pregnant female with peculiar tenderness; but there are so many counteracting influences which superstitious fears and religious ordinances call into action, that the most kindly attentions and affectionate regards shown to her, assume a colour of positive cruelty. When approaching delivery, she is indulged with whatever food she herself desires, or what her relatives consider best for her. She is allowed to eat no end of sour fruits, sweetmeats, and all kinds of rich and heavy food which are given to her from a common fear prevalent among the Hindus, that unless she eats well and to surfeit, her delivery will be prolonged. She is indulged with a variety of food without any regard to its wholesome or unwholesomeness from apprehension of accidents at child-birth. In fact, in the ninth or tenth month of her pregnancy, she eats a death meal or *saad* in the presence of visitors and relatives, her food consisting of all the delicacies which native cookery and the season can supply. When the hour of delivery arrives, she is obliged to leave her own apartments and is removed to a room generally on the ground floor of the house, damp and ill-ventilated, as such parts of a native house generally are. The reason for the change is that a woman after delivery is considered as in a state of uncleanness or moral impurity. All social intercourse with her is suspended for a time, the impurity in the case of a male issue lasting for twenty-one days, and in that of a female for a whole month. None but close relatives of her own sex are allowed to see her in her state of confinement, but at every time they come out of the lying-in room, they are obliged to change their clothes, and to purify themselves by ablution. It is easy to imagine the state of mind of the patient under such circumstances. Deprived of the ordinary comforts of

life, which cannot but be attended with the most serious consequences, she is denied all the sources of mental cheerfulness, companionship and society, at a time when cheerfulness and buoyancy of spirits are most needed in her delicate state of health. The native mode of treatment of women in accouchment is one of peculiar hardship and torture to the patient. Immediately after child birth, the umbilical cord instead of being cut with a sharp instrument, is rudely torn asunder by a piece of bamboo slice, thereby inflicting sometimes a permanent injury on the navel of the infant, and causing irritation which results in convulsions and tetanus which the child is seldom able to stand. In fact, the great mortality among native children immediately after birth is to be ascribed to this practice. A continually burning fire is kept up in the lying-in room even in the midst of the dog-days of April, raising the temperature of the room to at least 110 Fah. heat. Both the mother and the infant are made to lie by the fireside when they are subjected to a course of warm fomentation by the nurse's hand, literally producing blisters on their bodies. But external heat apart, the common mode of promoting internal warmth, is by administering large doses of spicy decoctions and pungent substances to the mother, which literally kill her appetite, and keep her in a state of feverish excitement for nearly a whole year.

The nursing and the nourishment of Hindu children are far from being congenial to a healthy development of their organs. A Hindu mother suckles her child, till it is three years old; she seldom employs a wet nurse, nor is the child fed with prepared food before the expiration of three years. If however before the child attains that age, the mother is pregnant, the child becomes sickly and begins to languish; for the mother's milk is now most deleterious, and the child continues to suck it, weaning being most difficult, as native mothers alone can testify, under such circumstances. The food of children after weaning, as I have already remarked, consists of sweetmeats which contribute little or no nourishment to the system, and are productive of bodily infirmities. Native children go naked till they arrive at their third or fourth year, and are thus exposed at a very critical time of their lives to changes of weather and atmosphere with no small detriment to their health. Native children in their unclad state are little remarkable for their

cleanliness. All their plays and amusements are with clay, brick dust, and ashes, with which their skins are thickly coated, and which their mothers seldom think of washing or rubbing off, ablutions and baths being considered not very healthful for children. Children of school-going age are somewhat better cared for, though in the villages you might yet see the little imps going all inked over for days and days together, without any sign of improvement in their dress or in their person.

The early marriages of the Hindus, besides the many social evils which they produce, are one among the many causes of the general unhealthiness and premature decline of the people of this country. These marriages induce forced maturity on the part of the married couple, the age of puberty being attained in both the cases at a much earlier age than is known in other tropical countries. It is not uncommon to see a girl of twelve with a child in her arms, and a boy father at the age of sixteen. A Hindu woman at twenty-five looks quite old, and is robbed of all the charms and freshness of youth. To these early marriages, we are undoubtedly to attribute the want of physical energy and manliness on the part of the men, and the general appearance of old age in the women of the country, before either of them have reached even the meridian of life.

The removal of the dying to the banks of the Ganges is another social practice of the Hindus, which militate against the laws of public health. This practice so abhorrent to every enlightened human feeling, derives its sanction from religion, and thus places the English medical attendant of the sick in an altogether false position. He feels his hands tied up, and himself powerless to interfere.

The above, gentlemen, is an unvarnished account of my experiences of the state of Hindu society, both as an ordinary member of that society and as a professional man. If time permitted, I could have entered on a minuter narrative than what I have been able to give you. But the subject is too vast to be disposed of in an address of a prescribed length. I shall, therefore, conclude by casting myself on your indulgence, and by thanking you for the kind attention with which you have listened to this imperfect sketch of Hindu social laws and habits viewed in relation to health.

APPENDIX A.

STATEMENT showing the properties of Articles of a Native Dietary.

ARTICLES OF FOOD.		Flesh ferments.	Heat givers.	Mineral matters.	Waters & Fatty matters.
Amylaceous.	RICE	7	78	1	14
	SAGO	4	82	1	13
	ARROW-ROOT AND TAPIOCA	2	23	1	74
	POTATOES	...	...	...	...
Sacchari- ferous.	SUGAR	0	100	0	0
Oleo- glycerous.	BUTTER AND GREE	0	100	0	0
Fibrous.	WHEAT	13	73	2	13
	<i>Panicum miliaceum</i>	...	...	...	...
	<i>Jowar</i>	9	74	1	16
	<i>Sorghum vulgare</i>	10	73	2	15
	Bajra	...	...	...	...
	<i>Penicillaria spicata</i>	12	70	1	17
	Kangni	17	69	3	11
	<i>Panicum miliaceum</i>	11	72	1	15
	OATMEAL	14	7	1	78
	BARLEY	22	14	1	63
Cereals.	GRAM	19	62	3	16
	Chullar Dhol	...	...	...	...
	<i>Cicer arietinum</i>	20	61	3	16
	PIKON PEA	...	...	...	...
	Urad Dhol	25	58	2	15
	<i>Cajanus indicus</i>	...	...	...	...
	COMMON PEA	24	59	2	15
	Matar Dhol	...	...	...	...
	<i>Pisum sativum</i>	...	...	...	...
	LENTIL	23	56	3	13
	Musoor Dhol	...	...	...	...
	<i>Ervum lens</i>	...	...	...	...
	VETCH	24	59	3	14
	Khosar Dhol	...	...	...	...
	<i>Lathyrus sativus</i>	...	...	...	...
	CHWOLE	24	59	3	14
	Barbuti Dhol	...	...	...	...
	<i>Dalichia sinensis</i>	...	...	...	...
	GREEN GRAM	24	60	3	13
	Mong Dhol	...	...	...	...
	<i>Phaseolus mungo</i>	22	62	3	13
	Maash Kolie Dhol	7	36	2	55
	<i>Phaseolus radiatus</i>	...	...	...	...
	GREEN PEAS	5	8	1	86
	MILK	...	...	...	...

N. B.—Flesh ferments are Nitro-aceous matters which supply nutriment and form the tissues of the body.
The Heat-givers or carbonaceous food consist of Starchy, Saccharine, and Oleagenous matters which supply fat and heat to the animal system.
Mineral matters are those which supply various salts which enter into the composition of the blood and tissues.

APPENDIX

STATEMENT showing the state of the Hooghly River

ANALYSIS OF HOOGHLY RIVER WATER, CALCULATED FOR A GALLON OF 70,000 GRAINS.	FORT-POINT.				CASSIPORE.			
	HIGH WATER.				HIGH WATER.			
	March 15, 1862.	April 14, 1862.	May 14, 1862.	June 12, 1862.	March 15, 1862.	April 14, 1862.	May 14, 1862.	June 12, 1862.
SOLID RESIDUE from filtered water	79.0	9.0	25.5	40.5	57.9	77.1	77.1	77.1
ORGANIC	9.0	9.0	4.9	7.6	6.9	7.6	7.6	7.6
INORGANIC	70.0	70.0	21.2	42.0	51.0	70.0	70.0	70.0
Silica	4	4	4	4	4	4	4	4
INSOLUBLE EARTHY SALTS	9.7	9.7	13.5	12.4	11.9	9.9	9.9	9.9
Carbonate of Lime } Held in Solution by Ditto of Magnesia } free carbonic acid- gas	8.5	8.5	9.5	9.5	9.5	8.5	8.5	8.5
Sulphate of Lime	1.2	1.2	4.0	2.9	2.3	1.4	1.4	1.4
SOLUBLE SALTS	69.9	69.9	7.3	29.4	38.7	60.8	60.8	60.8
Chloride of Magnesium	6.5	6.5	3	2.06	6.1	6.1	6.1	6.1
Sulphate of Magnesia	5.4	5.4	1.5	4.1	4.5	4.5	4.5	4.5
Chloride of Sodium	48.0	48.0	6.0	32.54	48.0	48.0	48.0	48.0
Sulphate of Soda	...	...	...	...	...	...	...	...
Carbonate of Soda	...	...	...	...	...	...	...	...
Sedimentary matter not dissolved in water	2.1	2.1	2.8	4.7	5.0	5.0	5.0	5.0
Organic	3.78	3.78	43.4	52.0	68.2	75.0	75.0	75.0
Inorganic	28.7	28.7	40.0	63.3	70.0	70.0	70.0	70.0

B.

water during the month of Cholera Epidemic.

Analysis of River water in January when it is much more free from impurities.

PULTAH GHAUT.				CHINSURAH.				JANUARY 4, 1863.			
HIGH WATER.				HIGH WATER.				HIGH WATER.			
March 15, 1862.	April 14, 1862.	May 14, 1862.	June 12, 1862.	March 15, 1862.	April 14, 1862.	May 14, 1862.	June 12, 1862.	Fort-Point.	Cassipore.	Pultah Ghaut.	Chinsurah.
19.83	16.8	21.9	25.5	19.2	16.2	17.5	15.31	21.1	19.0	21.9	20.3
3.6	1.8	3.9	3.5	3.0	2.8	2.9	2.5	2.9	2.6	4.2	2.7
16.23	15.0	18.0	22.0	16.2	13.4	14.6	12.81	18.2	16.4	17.7	27.6
1.0	1.9	5	1.1	6	3	8	6	1.2	1.0	4	17.3
13.3	12.18	12.2	10.4	13.5	10.9	11.4	10.2	14.7	14.1	15.3	15.3
9.3	...	7.5	7.5	9.4	...	6.9	6.3	10.8	10.5	11.1	11.2
4.0	...	4.8	2.9	4.1	...	4.5	3.9	3.9	3.6	4.2	4.1
...	...	...	...	...	...	...	...	...	...	...	...
1.93	2.7	5.3	10.5	2.1	2.2	2.4	2.0	2.3	1.3	2.0	2.0
...	...	...	1.1	...	...	...	...	...	...	...	...
...	...	...	1.6	...	...	...	...	...	...	...	...
6	...	3.6	7.8	7	...	1.6	1.4	1.7	...	6	6
13	...	1.7	...	1.5	...	7	6	Traces	Traces	Traces	Traces
12	...	...	1.25	...	1	Traces	6	...	1.4	1.4	...
...	4.7	5.4	...	10.0	2.4	Traces	Traces	...	6	Traces	...
11.0	16.8	40.0	52.2	13.0	12.7	25.2	13.2	4.4	5.6	16.8	8.1
...	...	35.3	46.8	...	...	15.2	10.8	...	...	16.2	...

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PROJET DE CONSTRUCTION
DU
NOUVEL HOTEL-DIEU
DE PARIS

RAPPORT

FAIT AU CONSEIL MUNICIPAL DE PARIS

PAR

Ambroise TARDIEU,

Membre du Conseil municipal,
Doyen de la Faculté de médecine de Paris, etc., etc.

PARIS

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Rue Hauteville, 19,

1865

PROJET DE CONSTRUCTION
DU
NOUVEL HOTEL-DIEU
DE PARIS

EXTRAIT
DES
ANNALES D'HYGIÈNE PUBLIQUE ET DE MÉDECINE LÉGALE,
2^e SÉRIE, 1865, T. XXIV.

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PROJET DE CONSTRUCTION

NOUVEL HOTEL-DIEU

DE PARIS

Le Conseil municipal de la ville de Paris est appelé par M. le sénateur, préfet de la Seine, à délibérer sur l'ensemble du projet de reconstruction de l'Hôtel-Dieu et sur les voies et moyens à l'aide desquels il sera procédé à cette opération.

Aucune affaire plus importante ne peut être soumise aux délibérations du Conseil; aucune ne se présente dans des conditions plus délicates et plus graves. Car si, d'une part, il est permis de la considérer comme parfaitement en état, grâce aux longues et consciencieuses études qui ont

(1) Rapport fait dans la séance du 24 mars 1865, au nom du comité n° 3, composé de MM. Dumas, président du conseil; Bonlatignier, président du comité; Monnin-Japy, vice-président; Decaux, secrétaire; Armand-Jeanti, baron Michel de Trétaigne, Collette de Baudicour, Desfossé, Dumont, A. Firmin-Didot, Florents, Ch. Merroux, Périllieux, Ségalas et Amb. Tardieu, rapporteur.

précédé le projet; au talent et aux soins minutieux avec lesquels les plans ont été dressés; aux discussions savantes dont ils ont subi l'épreuve, tant dans le conseil de surveillance de l'assistance publique, qu'au sein d'une commission spéciale, choisie parmi les médecins et chirurgiens des hôpitaux; aux modifications apportées dans les plans primitifs, pour donner, dans la mesure du possible, satisfaction aux objections et aux réserves qui s'étaient produites; à l'entente parfaite qui s'est établie entre M. le préfet et l'administration de l'assistance publique, sur les combinaisons financières à adopter; grâce enfin à la haute sollicitude que n'a cessé de marquer l'Empereur pour cette grande entreprise, depuis le jour où, dans une lettre mémorable, il mettait un terme aux délais qui en avaient retardé l'exécution, jusqu'à hier encore, où, se faisant rendre compte des projets préparés, il les laissait librement discuter devant lui et leur accordait une suprême sanction; d'un autre côté, il ne serait ni juste ni sage de méconnaître qu'autour de cette question de la reconstruction de l'Hôtel-Dieu, s'est élevé un mouvement d'opposition et de controverse, dans lequel la passion du bien et les prétentions de la science n'ont pas su toujours se préserver de l'exagération, mais qui, malgré tout, devait préoccuper une administration aussi éclairée que l'est celle de la ville de Paris, et lui faisait un devoir, alors qu'un intérêt d'humanité était invoqué, de ne pas repousser sans examen les protestations qui s'élevaient, quelque peu nombreuses qu'elles fussent, et de ne se décider qu'après les plus sérieuses et les plus mûres réflexions.

Le moment est venu de peser, sans parti pris comme sans faiblesse, les idées théoriques et les nécessités pratiques, de les concilier dans la reconstruction du nouvel Hôtel-Dieu, de passer, en un mot, de l'étude et de la discussion à l'action. Le Conseil municipal apportera dans l'apprécia-

tion des projets qui lui sont soumis, avec le ferme désir d'assurer et d'accroître le bien-être de la population pauvre, en lui donnant à la place du vieil Hôtel-Dieu qui tombe, un hôpital où rien ne lui manquera de tous les perfectionnements que l'industrie et la science ont réalisés de nos jours, l'intention non moins arrêtée de soutenir l'Administration dans les desseins où elle s'inspire des besoins qu'elle a mission de satisfaire, plus que d'un idéal qu'il serait imprudent de poursuivre et plus impossible encore d'atteindre.

Dans l'exposé que nous allons avoir l'honneur de soumettre au Conseil, et après avoir rappelé succinctement ce qu'a été et ce qu'est encore aujourd'hui l'Hôtel-Dieu, nous donnerons la description de l'hôpital qu'il s'agit d'élever d'après les plans qui sont placés sous nos yeux; nous en ferons connaître d'une manière rapide la disposition générale, les aménagements particuliers, et les services spéciaux; nous passerons en revue pour chacun d'eux et nous discuterons les critiques qui ont pu se produire: nous indiquerons en même temps les remarques que, sur quelques points, l'étude de ces plans a suggérées au comité. Passant ensuite à l'examen des voies et moyens proposés pour faire face aux dépenses de toute nature que doit entraîner la reconstruction de l'Hôtel-Dieu, nous nous attacherons à montrer dans quelle situation réciproque la combinaison financière que le Conseil aura à apprécier devra placer l'administration de l'assistance publique et celle de la ville de Paris. Le projet de délibération qui sera proposé à l'adoption du Conseil résumera les différentes parties de ce rapport.

Mais, avant d'entrer en matière, nous devons énumérer les pièces dont communication nous a été faite par M. le sénateur, préfet de la Seine, et qui, comprenant tous les éléments de la question, nous ont permis d'en acquérir rapidement une connaissance complète et ont rendu pos-

sible la tâche si difficile imposée au rapporteur. Ces documents, qui contiennent non-seulement le projet lui-même, mais les pièces de l'Instruction administrative à laquelle celui-ci a été soumis, sont au nombre de neuf, savoir :

1° L'avant-projet et les plans préparés par MM. Gilbert et Diet, architectes, pour la reconstruction des bâtiments de l'Hôtel-Dieu, avec devis et atlas contenant 10 feuilles ;

2° Un avant-projet dressé par M. Ser, ingénieur de l'administration de l'assistance publique, avec plan et devis des travaux spéciaux qui rentrent dans sa compétence ;

3° Les procès-verbaux et le rapport de la Commission médicale appelée, au mois d'octobre 1864, par M. le Directeur de l'administration générale de l'assistance publique, à émettre un avis sur le projet de reconstruction ;

4° et 5° Deux mémoires présentés au conseil de surveillance par M. le Directeur de l'administration générale de l'assistance publique, en date des 23 février et 2 mars 1865, sur les travaux de reconstruction et sur les voies et moyens ;

6° Un tableau, avec évaluation sommaire des dépenses, des divers projets à exécuter par l'administration de l'assistance publique ;

7° Le rapport de la commission du conseil de surveillance chargé d'examiner la question de la construction du nouvel Hôtel-Dieu ;

8° L'avis délibéré sur cette affaire par ledit conseil dans sa séance du 23 mars 1865 ;

9° Le rapport récapitulatif adressé le même jour à M. le Sénateur, Préfet de la Seine, par M. le Directeur de l'administration générale de l'assistance publique.

On trouvera, dans le rapport qui va suivre, l'analyse de ces divers documents, dont la seule mention peut déjà faire pressentir l'importance.

I. — Ce n'est pas ici le lieu, ce ne serait pas d'ailleurs au Conseil municipal de la ville de Paris qu'il serait utile de redire les origines et le passé de l'Hôtel-Dieu ; qu'il suffise de rappeler que durant plus de dix siècles, au cœur de la vieille cité, au pied de Notre-Dame, en face du palais de saint Louis, sous les noms pieux de Maison-Dieu, de Grand hospice d'humanité, d'Hôtel-Dieu, un asile a été ouvert à la souffrance ; et qu'aujourd'hui, bien qu'il ne reste plus une pierre du premier édifice, dans cet hôpital mutilé, morcelé, dissocié, mais encore soutenu par l'antique noblesse de ses services et de son nom, plus de huit cents malades reçoivent les secours de la médecine et de la charité publique. Et cependant il y a tout près de cent ans que la question du déplacement de l'Hôtel-Dieu s'agite. Il est vrai que ce projet était né de l'horreur qu'inspiraient à tous l'installation intérieure de cet hôpital et les tableaux qu'ont pu y voir encore à la fin du siècle dernier des témoins dont l'émotion s'est transmise jusqu'à nous. C'est de l'un d'eux que l'illustre président du conseil, M. le sénateur Dumas, tient directement les détails qu'il a exposés en termes saisissants au sein du comité, et que Bailly, Tenon, la Rochefoucauld-Liancourt, ont décrits dans leurs admirables mémoires. Les malades y étaient entassés au nombre de quatre ou cinq mille dans 1,877 lits de dimensions variables, dont les grands contenaient quatre et quelquefois jusqu'à six ou huit malades à la fois (1), forcés ainsi de subir la vue des

(1) Cette promiscuité qui, à la seule pensée, révolte le cœur et la raison, et qui semble si loin de nous, se retrouve, à un moindre degré, il est vrai, mais toujours repoussante, dans le pays où l'on a été si souvent chercher des modèles à opposer à notre régime d'assistance publique. Les *Work-houses* de Londres qui, en raison de la population qu'ils reçoivent, sont, à bien des égards, plus directement comparables avec nos établissements hospitaliers que les grands hôpitaux anglais, renferment encore dans les services d'accouchement et de vieillards des lits qui reçoivent deux

opérations, les angoisses de l'agonie et le contact de la mort les uns des autres.

L'Hôtel-Dieu, malgré le soulèvement de l'opinion, successivement agrandi, mais non déplacé, avait résisté même à l'incendie terrible qui le détruisit en partie en 1772, et à la recrudescence des réclamations que suscita ce désastre en faveur d'une reconstruction devenue inévitable. Plus tard, à une époque voisine de nous, après qu'un sentiment plus vif de la dignité humaine, une charité plus intelligente et plus vraie, et l'autorité de la science mieux comprise eurent réussi à transformer le régime intérieur des établissements hospitaliers, on voit l'opinion publique s'apaiser et l'Hôtel-Dieu défendu par le respect du peuple, qui l'entourait encore et le protégeait à l'heure même où nous sommes. Il l'était non moins énergiquement par les médecins et chirurgiens éminents dont la renommée faisait sa gloire et qui, en 1824, en 1838, s'opposaient avec chaleur au déplacement projeté et soutenaient la nécessité de le conserver, en proclamant « la position heureuse, la bonne exposition, » la salubrité de l'Hôtel-Dieu, qui, ajoutaient-ils en prévision d'une reconstruction plus ou moins prochaine, ne pourrait être remplacé que par un hôpital aussi grand, aussi central, à la portée du même quartier, réunissant les mêmes conditions de salubrité (1). »

Il est impossible de n'être pas frappé de cette situation

personnes. J'ai vu dans le *Work-house* de Lambeth, dans l'un des quartiers les plus considérables de la rive droite de la Tamise, un service de femmes en couches, où deux femmes et deux enfants occupent un lit qui n'a pas plus de 1 mètre 20 centimètres de largeur. On éprouve quelque satisfaction à se dire que l'on ne trouverait rien de pareil dans notre pays, en dépit des critiques injustes dont l'administration de l'assistance publique a été l'objet.

(1) Les noms seuls que nous allons citer, et qui sont ceux des signataires de la note de 1824 et du mémoire de 1838, disent assez quelle autorité doit s'attacher à l'opinion de tels hommes : Dupuytren, Petit,

générale et de ce mouvement des esprits dans une question où le sentiment a une part que la raison même ne saurait lui refuser. A tous les points de vue, en effet, l'Hôtel-Dieu se présente avec un caractère particulier qu'on ne peut méconnaître, et dont une administration vigilante et soucieuse avant tout du bien public doit de toute nécessité tenir compte. Il est pour le peuple de Paris le symbole de la bienfaisance au seuil de l'antique cathédrale; il est, pour rentrer dans une voie purement pratique, un hôpital d'enseignement, un foyer nécessaire d'instruction, le centre de l'éducation médicale et chirurgicale clinique, où la Faculté dispense la science et institue les épreuves que doivent subir les aspirants au doctorat. Il est encore à proximité du siège de l'administration de l'assistance publique, le refuge des malades les plus gravement atteints parmi ceux qui, n'ayant pu trouver place dans les autres hôpitaux, affluent en grand nombre vers le bureau central d'admission; de telle sorte que l'Hôtel-Dieu est non pas seulement l'asile ouvert aux misères de la population d'une circonscription limitée, mais par excellence l'hôpital général et central. Il faudrait, pour lui dénier ce titre, oublier de quelle utilité immense il a été par sa situation même dans les grandes épidémies et dans les temps de troubles qu'ont traversés nos générations. Il offre enfin à l'administration une ressource dont elle ne pourrait être privée sans dommage, soit pour les études qu'elle poursuit incessamment sur les diverses parties du régime hospitalier, soit pour les concours publics à l'aide desquels s'opère d'une manière à la fois si brillante et si sûre le recrutement du corps médical des hôpitaux de Paris. Ces nécessités, auxquelles l'Hôtel-Dieu seul peut satisfaire, sont si impérieuses, que, dans l'état de ruine où il est actuellement, il ne subsiste en réalité que pour y faire

Magendie, Récamier, Breschet, Roux, Blandin, Gueneau de Mussy, Caillaud, Honoré, Husson, Jadinoux et Louis.

face; et que, s'il est urgent de le reconstruire, il paraît impossible de le déplacer.

Une seule considération, primant toutes celles que nous venons de rappeler, eût pu motiver la décentralisation de l'Hôtel-Dieu : c'est celle de la salubrité. En plus d'une circonstance, la situation qu'il occupe a été violemment accusée d'être insalubre; il est même curieux, ainsi que le faisait remarquer M. Dumas, de voir les savants réformateurs de l'ancien Hôtel-Dieu incliner à mettre sur le compte de l'emplacement de l'hôpital les effets désastreux et très-manifestes de l'encombrement des lits et des salles. C'était là pourtant qu'étaient les vraies causes d'insalubrité, et, quand elles ont disparu, les médecins les plus instruits ont reconnu que, malgré les apparences, si défavorablement situé, si mal construit, si médiocrement aménagé, si mal-propre, si humide qu'il semble, l'Hôtel-Dieu n'est pas plus malsain que les autres grands hôpitaux (1).

La question de salubrité générale peut donc être à bon droit écartée ou du moins réservée, et l'administration, qui a reçu de l'Empereur et qui accepte sans hésitation la tâche d'opérer enfin la reconstruction de l'Hôtel-Dieu, reste en présence des considérations et des exigences que nous avons précédemment exposées.

Il en est une qui domine toutes les autres, et qui, dans le moment présent, mérite toute la sollicitude et com-

(1) La mortalité comparative de ces divers établissements peut fournir à cet égard des renseignements qui, sans donner une absolue certitude, car la mortalité dépend de causes trop complexes pour être considérée exclusivement comme la mesure de la salubrité, ne sont cependant pas dépourvus d'intérêt. Nous la résumons dans ses résultats généraux pour les soixante dernières années, et nous nous contentons de faire remarquer combien sont petites et variables les différences qui séparent entre eux à ce point de vue les établissements les plus dissemblables. Dans les tableaux ci-dessous les hôpitaux sont rangés dans l'ordre de la moindre mortalité, et le chiffre de celle-ci est calculé sur cent décès. Nous n'avons pas

mandé, à vrai dire, les résolutions de l'administration municipale. M. le Préfet de la Seine l'a bien compris, et, dès le principe, sans varier un seul jour, il s'est attaché à la faire prévaloir en appuyant de sa haute autorité le double principe de l'Hôtel-Dieu maintenu dans la cité et d'un

besoin d'ajouter que ces données brutes, recueillies en dehors de toute catégorisation et de toute analyse statistique, n'ont qu'une valeur comparative très-générale dont nous nous gardons bien d'exagérer la portée.

*Mortalité pour 100 dans les hôpitaux généraux de Paris,
de 1804 à 1863.*

1804-1813.		1830-1839.		1850-1859.	
1	Cochin..... 13,98	Pitié..... 9,43	Cochin..... 9,78		
2	Charité..... 14,43	Cochin..... 10,96	Saint-Antoine... 10,45		
3	Necker..... 16,72	Charité..... 10,86	Charité..... 10,61		
4	Pitié..... 17,72	Hôtel-Dieu..... 12,27	Pitié..... 11,04		
5	Saint-Antoine. 18,01	Necker..... 12,59	Necker..... 11,66		
6	Beaujon..... 18,14	Beaujon..... 13,24	Beaujon..... 11,85		
7	Hôtel-Dieu... 20,19	Saint-Antoine.. 13,72	Hôtel-Dieu.... 11,92		

1861.		1862.		1863.	
1	Cochin..... 10,46	Charité..... 9,96	Cochin..... 8,97		
2	Necker..... 10,54	Hôtel-Dieu... 11,63	Charité..... 10,52		
3	Charité..... 10,69	Saint-Antoine.. 11,65	Beaujon..... 10,96		
4	Saint-Antoine. 11,96	Beaujon..... 11,68	Saint-Antoine.. 11,44		
5	Beaujon..... 12,06	Necker..... 12,64	Hôtel-Dieu.... 11,89		
6	Hôtel-Dieu... 12,48	Cochin..... 12,90	Necker..... 12,28		
7	Pitié..... 14,09	Pitié..... 13,15	Pitié..... 13,41		

Si l'on compare les places qu'occupe successivement dans les différentes périodes chacun des hôpitaux généraux, on voit que l'Hôtel-Dieu, Beaujon et la Pitié sont exactement sur la même ligne. Pour les quatre dernières l'hôpital Lariboisière, que nous n'avons pas fait figurer dans le tableau, pour ne pas modifier le classement général, occupe :

De 1850 à 1859.	le 7 ^e rang, avec une mortalité de	11,88 pour 100.
En 1861.....	le 7 ^e rang,	idem. 13,75 —
En 1862.....	le 5 ^e rang,	idem. 12,99 —
En 1863.....	le 7 ^e rang,	idem. 12,63 —

nombre à peu près égal de lits maintenus dans l'Hôtel-Dieu. Ce nombre est actuellement de 828. Le Conseil connaît trop bien les ressources actuelles dont dispose à Paris l'assistance publique, pour qu'il soit besoin d'insister sur l'insuffisance notoire des lits existant dans les hôpitaux généraux, et sur l'impossibilité d'en restreindre le nombre. Des projets ultérieurs dont nous aurons à parler, et qui permettent de prévoir la création de nouveaux établissements hospitaliers, ne compenseraient pas la diminution immédiate du nombre des lits destinés au traitement des affections médicales et chirurgicales, et sont seulement destinés à remédier utilement dans l'avenir à l'impuissance regrettable où se trouve l'assistance publique de s'étendre à toutes les misères. Il suit de là que l'on ne peut, sans imprudence, songer à diminuer, d'une manière notable, l'importance du nouvel Hôtel-Dieu, pas plus qu'on ne doit l'éloigner des lieux où s'est fondée et où a grandi sa renommée dix fois séculaire. On en revient forcément aux termes posés il y a trente ans par les médecins et les chirurgiens de l'Hôtel-Dieu, qui ne consentaient à le voir remplacé que par un hôpital aussi grand et aussi central.

II. — ANALYSE ET DESCRIPTION DES PLANS ET PROJETS. — Ces principes une fois posés, et le Comité espère que le Conseil n'hésitera pas à les admettre, il s'agit de rechercher, dans une étude attentive des plans qui nous ont été communiqués, si l'application de ces principes est possible, et si elle a été réalisée dans les conditions hygiéniques, économiques et architecturales les plus favorables. Une description rapide des dispositions adoptées permettra d'en juger. Il importe toutefois de faire remarquer qu'on ne doit pas s'attacher trop étroitement à la lettre; il ne s'agit, quant à présent, que d'avant-projets; et en ce qui touche surtout certaines parties techniques, certains mo-

tifs, certains détails de style qui sont destinés à être modifiés ou remaniés dans l'harmonie générale, le Conseil peut, sans crainte, s'en rapporter au goût et à l'habileté des deux architectes placés à la tête de cette grande entreprise, ainsi qu'à la haute direction qu'ils ne peuvent manquer de recevoir. Il sera donc exclusivement question, dans les développements qui vont suivre, de ce qui concerne à proprement parler l'hôpital, et de la manière dont sont conçus et distribués les différents services dont il se compose.

Emplacement de l'Hôtel-Dieu. — Il n'y a pas lieu de revenir sur l'emplacement définitivement choisi pour la reconstruction de l'Hôtel-Dieu; il a été précédemment fixé par une délibération du Conseil municipal du 30 septembre dernier (1), et est circonscrit, comme on sait, par la place

(1) Nous croyons utile de reproduire ici le texte de cette délibération:

Extrait du registre des procès-verbaux des séances du Conseil municipal de la ville de Paris (séance du 30 septembre 1864).

Présents: MM. Auger, F. Barrot, Bayet, Billard, Chaix d'Est-Ange, Decaux, Denière, Devinck, V. Dillais, Duhamel, Dumas, Fère, Fouché-Lepelletier, V. Foucher, G. de Charvac, Gouin, Hébert, Lebaudy, le chevalier Lefortier de la Garenne, Legendre, Lemoine, Lenoir, Merreau, Monnin-Japy, E. Moreau, Oudot, Paillard de Villeneuve, Picard, Pessoz, Ravaut, Teissonnière, G. Thibaut, Thiboumery, Varin.

Le Conseil,

Vu le mémoire de M. le sénateur, préfet de la Seine, en date du 26 septembre présent mois, concernant le projet de déplacement de l'Hôtel-Dieu et de sa reconstruction sur un autre emplacement, ledit projet contenant les dispositions suivantes:

- 1° La formation du périmètre du nouvel Hôtel-Dieu et ses dépendances;
- 2° L'agrandissement de la place du Parvis-Notre-Dame;
- 3° La rectification et l'élargissement à 20 mètres de la rue d'Arcole;
- 4° L'élargissement à 20 mètres de la rue de la Cité;
- 5° La fixation des alignements définitifs de la rue du Cloître-Notre-

du Parvis-Notre-Dame, la rue d'Arcole, le quai Napoléon et la rue de la Cité. Nous n'en parlerons que pour consigner

Dame, de partie du quai Napoléon, du quai Desaix, de l'avenue de Constantine et de la voie d'isolement du nouveau tribunal de commerce entre cette avenue et le quai Desaix ;

Vu le plan sur lequel ces diverses dispositions sont indiquées par des liserés bleus ; ledit plan indiquant également les côtes de nivellement des voies ci-dessus énumérées ;

Vu le procès-verbal de l'enquête à laquelle ces projets ont été soumis à la mairie du 4^e arrondissement, ensemble les diverses pièces y annexées ;

Vu le rapport du directeur de la voirie et celui du directeur de l'administration générale de l'assistance publique ;

Considérant que depuis longtemps l'administration a reconnu la nécessité de reconstruire l'Hôtel-Dieu, dont les bâtiments actuels ne sauraient être conservés, tant à raison de leur vétusté que parce qu'ils sont insuffisants pour les besoins du service ; que, suivant le projet, le nouvel Hôtel-Dieu sera circonscrit par la place du Parvis-Notre-Dame, agrandie jusqu'à la Seine, le quai Napoléon, la rue d'Arcole, redressée et élargie à 29 mètres, et la rue de la Cité également élargie à 29 mètres ; qu'il serait impossible de trouver au milieu de la ville une situation plus convenable au point de vue des besoins de la population et des nécessités du service ; que l'emplacement désigné, dont la superficie est d'environ 20 000 mètres, outre l'avantage de sa position centrale, réunit toutes les conditions d'aération et de salubrité que l'on doit désirer pour un établissement de cette nature ;

Considérant que les opérations de voirie accessoires qui se rattachent à ce projet sont bien conçues et présentent l'ensemble le plus satisfaisant, au double point de vue de la salubrité et des facilités de la circulation ; Considérant que ce projet paraît avoir été reçu généralement avec faveur par le public ; que toutefois des observations ont été présentées, quelques-unes par des hommes spéciaux ; qu'elles ont été examinées et discutées dans les rapports ci-dessus visés des directeurs de la voirie et de l'administration générale de l'assistance publique, qui proposent de maintenir le projet dans toutes ses dispositions ;

Délibère :

Il y a lieu,

1^o D'approuver et de faire déclarer d'utilité publique le projet de suppression de l'Hôtel-Dieu actuel et de sa reconstruction sur l'emplacement circonscrit par la place du Parvis-Notre-Dame, le quai Napoléon, les rues d'Arcole et de Constantine, ainsi que l'ensemble des opérations de voirie

ici l'approbation sans réserve qu'a donnée à ce choix la commission médicale instituée avec l'autorisation de M. le sénateur, préfet de la Seine, par M. le directeur de l'administration générale de l'assistance publique, et que résume en ces termes le rapporteur de cette commission, M. le docteur Broca, l'un des chirurgiens les plus distingués des hôpitaux.

« L'emplacement proposé nous paraît réunir la plupart » des conditions désirables ; et il serait difficile d'en trouver » un meilleur dans la région centrale où l'Hôtel-Dieu doit » être reconstruit. » Ce jugement nous dispense de toute autre remarque, et c'est seulement pour mieux faire comprendre la description qui va suivre que nous rappellerons ces conditions favorables de l'emplacement du futur Hôtel-Dieu.

Celui-ci est orienté du nord au midi, et de ces deux côtés il s'ouvre sur de larges espaces, par le parvis Notre-Dame, le petit bras de la Seine et la largeur d'un double quai d'une part ; de l'autre par les quais du nord, le grand bras de la Seine et la place de l'Hôtel-de-Ville. Sur cette face, ainsi qu'on l'a fait justement observer, le voisinage d'un grand fleuve et son courant rapide constituent une voie naturelle et puissante d'aération. A l'est et à l'ouest, les rues d'Arcole et de la Cité, sans offrir d'aussi larges espaces, seront cependant agrandies dans des proportions assez con-

ci-dessus décrites, qui se rattachent à ce projet principal ; le tout conformément aux tracés figurés par des liserés bleus sur le plan ci-dessus visé ;

2^o Et d'autoriser la ville de Paris à acquérir soit à l'amiable, soit par voie d'expropriation, dans les formes prescrites par la loi du 2 mai 1841, et aussi par application du décret du 26 septembre 1852, sur la voirie de Paris, les immeubles ou portions d'immeubles nécessaires à l'exécution de ces projets.

Signé au registre :

DUMAS, président.

E. MOREAU, secrétaire.

sidérables pour que les abords de l'Hôtel-Dieu l'emportent sur ceux de la plupart des hôpitaux connus. Il n'est pas nécessaire de relever une erreur qui s'est cependant reproduite avec une certaine persistance, et de faire remarquer que, d'aucun côté, l'Hôtel-Dieu n'a à redouter l'ombre de la cathédrale. Enfin si nous ajoutons que, perpendiculairement à la face occidentale, l'avenue de Constantine aboutissant au Palais de Justice favorisera le courant de l'air d'une extrémité de l'île de la Cité à l'autre, on reconnaîtra qu'au point de vue de l'hygiène, en ce qui touche l'orientation, l'exposition générale et l'aération, le nouvel Hôtel-Dieu réunit les meilleures conditions et ne saurait être sérieusement critiqué, surtout si on le compare à la situation actuelle qu'il occupe sur le petit bras de la Seine, baignant dans l'eau du fleuve; ou même à d'autres hôpitaux construits sur des points les plus élevés et qui, peut-être à cause de cette altitude même, sont en réalité moins salubres qu'on ne serait tenté de le croire. Nous le répétons, le Conseil municipal n'a plus à se préoccuper du choix de l'emplacement qu'une délibération antérieure a fixé et qu'il n'y aurait d'ailleurs aucun motif sérieux de modifier.

Aperçu général des constructions et des dispositions intérieures du nouvel Hôtel-Dieu. — Nous arrivons à la question actuelle, à l'avant-projet des constructions. Celles-ci se développent dans les limites que nous venons de retracer et dont le périmètre comprend une superficie totale d'environ 22200 mètres; elles peuvent se diviser en trois parties distinctes.

La première est formée par l'avant-corps et s'étend en façade sur la place du Parvis-Notre-Dame, où est l'entrée principale du nouvel Hôtel-Dieu. Celle-ci donne accès dans un premier vestibule de 160 mètres de superficie, des deux côtés duquel elles se trouvent, à gauche le concierge et le

service des consultations externes, comprenant : salle d'attente, cabinets de médecins, trois pièces de pansement et dépendances nécessaires; à droite, le service des admissions avec salle d'attente et bureau d'enregistrement, le cabinet du directeur et celui de l'économe. Dans la partie de la façade qui correspond à ce vestibule, les bâtiments sont à rez-de-chaussée seulement, de manière à intercepter le moins possible l'air et les rayons du soleil. Mais des deux côtés la façade s'élève; le premier étage est occupé par les appartements du directeur, de l'économe, du pharmacien en chef, des aumôniers et des employés; le second contient vingt-huit chambres destinées aux élèves internes, auxquelles on arrive par un escalier particulier et par un corridor bien éclairé. Dans les combles, sont les logements et dortoirs des gens de service, avec un escalier séparé pour chaque sexe.

Dans cette première partie, à la suite du vestibule d'entrée, est une cour carrée, accessible aux voitures et aux brancards qui amènent les malades, et autour de laquelle règnent des galeries de communication. De chaque côté, deux vastes amphithéâtres pour les leçons cliniques et les opérations, d'où l'on peut passer de plain-pied dans les salles de chirurgie, sans que les opérés soient exposés à l'air extérieur.

De cette cour, on accède à un second vestibule, dit Salle des fondateurs, à gauche duquel est une salle de réunion pour les médecins, et à droite le cabinet et les laboratoires du pharmacien en chef et les salles de garde des élèves. Autour et au-dessus de la cour carrée est disposée une terrasse qui domine la place du Parvis, et dont les côtés sont occupés, au premier étage, par deux amphithéâtres latéraux semblables à ceux du rez-de-chaussée, avec les deux pièces accessoires et une salle de 10 lits, avec toutes ses dépendances, dont l'affectation au service de chirurgie indiquée

sur le plan fera l'objet d'une réserve très-sérieuse ; au deuxième étage, par le service d'accouchement, partagé en quatre salles de 2, 4, 6 et 10 lits, avec leurs dépendances isolées, et deux chambres de travail.

Ici s'arrête cette première partie ou avant-corps du nouvel Hôtel-Dieu.

Il faut franchir la première cour et le second vestibule, pour pénétrer dans l'hôpital proprement dit, qui, lui-même, peut se décomposer en trois groupes de constructions disposées autour d'une cour centrale, longue de 77 mètres. Un grand bâtiment longitudinal à deux étages, sous combles, s'étend dans toute la longueur de cette cour, dont la largeur, qui est de 35 mètres à la partie supérieure, n'est plus que de 25 mètres au rez-de-chaussée et au premier étage, où une galerie de communication extérieure est prise et s'ouvre en arcades sur la cour intérieure. C'est là le premier groupe de constructions.

A ce double bâtiment longitudinal viennent se rattacher deux groupes de pavillons transversaux : trois à droite pour les hommes, trois à gauche pour les femmes. Les pavillons n'ont que deux étages, y compris le comble ; ils sont isolés de trois côtés et séparés les uns des autres par des préaux plantés d'arbres, de 37 mètres 60 centimètres de large sur 34 mètres de long. Ce sont ces pavillons qui forment, à proprement parler, l'habitation des malades ; et l'étendue des préaux sur lesquels les salles prennent jour, ainsi que la hauteur des bâtiments sont calculées de telle sorte que l'insolation et l'aération en soient librement assurées.

La distribution intérieure de ces divers groupes de constructions mérite d'être indiquée avec quelques détails. Chaque pavillon renferme trois salles superposées, contenant de 26 à 30 lits, espacés entre eux de 2 mètres 50 centimètres, et dont les dimensions donnent un cubage de 56 mètres 28 centimètres à 60 mètres 80 centimètres. Les

fenêtres montent jusqu'au plafond et descendent jusqu'à 20 ou 30 centimètres du sol ; elles occupent les deux côtés, et, de plus, il en existe une largement ouverte à l'extrémité de chaque salle, dont l'entrée est occupée par le cabinet de la religieuse donnant sur l'intérieur et par une pièce où sont placés une baignoire et des lavabos. Outre cette triple rangée de salles principales comprenant l'ensemble des pavillons, les services sont complétés par une salle de six lits et deux chambres à un lit qui, placées dans le bâtiment longitudinal hors des pavillons, en sont complètement distinctes. C'est là aussi que se trouvent disposés l'office et les cabinets d'aisances, les appareils mécaniques, dont nous reparlerons, et enfin une salle de réunion pour les convalescents.

La dernière partie de l'hôpital est celle qui en forme la limite septentrionale et qui est en façade sur le quai Napoléon. Le centre en est constitué sur la cour intérieure, qu'elle ferme de ce côté, par la chapelle située au premier étage, et à laquelle on monte par un escalier monumental. C'est à elle que se rattachent les services funéraires, les salles des morts et d'autopsie, et la cour inférieure, dans laquelle le mouvement des chars mortuaires pourra s'opérer hors de la vue de tous.

Cette partie comprend encore la communauté des religieuses Augustines, dont l'installation est complète : parloir, salle capitulaire, salle de récréation, dortoirs, cuisine, etc., le service de la lingerie, et enfin, comme annexe obligée du nouvel Hôtel-Dieu, le bureau central d'admission de l'administration de l'assistance publique, ouvrant sur le quai avec cour et entrées spéciales à couvert, salle d'attente, cabinet des médecins et dépendances.

Pour compléter cette description, il convient d'ajouter que, dans toute l'étendue de l'établissement, est ménagé un vaste sous-sol, prenant jour et air sur une cour à l'anglaise.

qui borde la base des bâtiments. Cette disposition permet de placer, sans rien retrancher à l'espace qu'exigent les malades, et de disposer largement les services généraux, tels que la cuisine et ses dépendances, la pharmacie, les bains, la buanderie, les réfectoires des gens de service et de vastes magasins appropriés à tous les besoins de l'hôpital, dont l'approvisionnement se fera de la manière la plus facile et la plus commode par une cour particulière réservée, dans la partie occidentale de l'édifice, en face de l'avenue Constantine.

Services spéciaux. — Telle est l'économie générale des plans projetés pour le nouvel Hôtel-Dieu. Nous n'en aurions cependant donné qu'une idée insuffisante, si nous ne disions quelques mots des services spéciaux qui tiennent une si grande place dans la constitution actuelle d'un hôpital, et pour lesquels des projets particuliers ont été élaborés par l'habile ingénieur de l'administration de l'assistance publique, M. Ser. Nous voulons parler du chauffage, de la ventilation, de l'éclairage, du service des eaux, des transports mécaniques, etc. Un mémoire très-bien fait et très-complet, communiqué au conseil, fournit sur ces divers points les renseignements les plus précis.

Chauffage. — Les différents moyens de chauffage applicables à un grand hôpital y sont successivement examinés; et après avoir écarté les poêles simples, d'un entretien difficile et coûteux, les calorifères à air chaud, qui donnent une chaleur lourde et pénible, les cheminées à foyer découvert, qu'il faudrait multiplier outre mesure et qui entraîneraient trop de frais, si l'on voulait en obtenir un chauffage suffisant dans les salles de malades, l'avant-projet donne la préférence pour le nouvel Hôtel-Dieu à un système mixte, combiné du chauffage à l'eau chaude et du chauffage à la vapeur.

Les chaudières sont établies dans la cour de service du bureau central, à l'extrémité nord-ouest de l'hôpital. Une entrée particulière permet d'y amener directement le charbon. La vapeur produite suffira à la fois pour le chauffage de tout l'établissement, la distribution d'eau chaude dans les offices, la cuisine, la pharmacie, les bains d'eau et de vapeur, et enfin la machine motrice des ventilateurs et des pompes. Les tuyaux qui l'amènent aux différents services sont placés dans la galerie qui règne dans le sous-sol tout autour de l'hôpital. Le chauffage des salles se fait par les calorifères à eau, chauffés au moyen de serpentins dans lesquels circule la vapeur. L'air chauffé au contact de ces appareils se rend, par des conduits ménagés dans l'épaisseur des murs, dans les salles des malades, où il entretient une bonne et douce température. La masse d'eau chaude renfermée dans les poêles constitue une réserve abondante de chaleur, qui procure à la température une stabilité parfaite, malgré les variations d'intensité des foyers. Des registres convenablement disposés permettent de régler et de suspendre l'arrivée de l'air chaud dans une partie quelconque de l'hôpital et même dans une fraction de salle. L'expérience et le calcul se réunissent pour démontrer que ce système de chauffage peut être établi dans des conditions économiques très-satisfaisantes. Il est, en outre, applicable à tous les services sans exception. On réserve seulement pour les salles de réunion des convalescents les cheminées à foyer découvert, dont l'aspect est plus agréable et l'action en quelque sorte plus réconfortante.

Ventilation. — Le renouvellement de l'air dans les salles de malades du nouvel Hôtel-Dieu est assuré par un système mixte qui, réunissant les avantages des deux grandes méthodes de ventilation par insufflation et par appel, échappe aux critiques que chacune d'elles, prise isolément, s'est attirée tour à tour. En effet, dans l'avant-projet que nous

analyses pour en rendre au Conseil municipal l'examen plus facile, l'air neuf est insufflé par des ventilateurs placés dans le sous-sol, en même temps que l'air vicié est emporté par six cheminées d'évacuation établies à la rencontre des pavillons et des bâtiments longitudinaux.

Les premiers vont puiser l'air à une grande hauteur sur la face septentrionale de l'hôpital dans le vaste espace qui s'étend au-dessus des quais, du grand bras de Seine et de la place de l'Hôtel-de-Ville : cet air pur est conduit à la partie inférieure de chaque pavillon par des canaux souterrains dont la température constante de 10 degrés le réchauffe en hiver et le rafraîchit en été. Là, après avoir circulé dans les calorifères, suivant les besoins du chauffage, il débouche par quatre orifices disposés à 1 mètre 50 centimètres de hauteur environ dans l'axe de chaque salle. Il s'élève jusqu'au plafond et redescend par couches successives pour servir à la respiration et à l'entraînement des miasmes.

Quant à l'évacuation de l'air vicié, celui-ci s'échappe par des orifices ménagés au niveau du plancher dans les murs des pavillons et aboutissant à une vaste cheminée où un appel énergétique est entretenu en été aussi bien qu'en hiver par la chaleur des réservoirs d'eau chaude destinée aux offices qui sont placés à la partie inférieure.

Le renouvellement de l'air est calculé à raison de 100 mètres cubes par heure et par lit, et cette quantité peut encore au besoin être notablement augmentée : une machine de la force de huit chevaux, dont la vapeur est d'ailleurs utilisée à bien d'autres services, suffit largement à mettre en mouvement les ventilateurs ; ce qui est une garantie contre l'élévation de la dépense, de même que les dispositions proposées pour utiliser dans la cheminée d'appel la chaleur des réservoirs d'eau chaude.

Toutes les parties de l'hôpital, à l'exception des salles de

malades, seront éclairées au gaz ; les dispositions de ce service n'offrent rien de particulier.

La distribution d'eau est assurée, d'une part, par sa double origine dans la Seine et dans l'Ourcq, et dans une prise double de chacune de ces eaux, aux deux extrémités de l'hôpital ; par l'établissement des réservoirs, les uns au rez-de-chaussée, les autres dans les combles, et par le jeu de pompes mues à la vapeur pour le cas où la pression ne suffirait pas à monter l'eau dans la cuvette de distribution des étages supérieurs.

Des monte-charges et des chemins de fer servent à la réception et au transport des divers approvisionnements. De la cour de service située au rez-de-chaussée un treuil hydraulique les fait descendre dans le sous-sol, où de petits wagons, roulant sur un chemin de fer, les portent à leur destination. D'autres treuils hydrauliques font mouvoir des monte-charges à l'aide desquels, de la cuisine, de la pharmacie et des magasins, les aliments, les médicaments et les divers objets peuvent être montés aux étages supérieurs.

Ces treuils sont disposés de manière à pouvoir prendre les malades sur une civière au rez-de-chaussée pour les élever à l'étage où se trouve la salle qu'ils doivent occuper. La dépense d'eau employée pour mettre les monte-charges en mouvement sera d'autant moins considérable qu'on en utilisera la plus grande partie pour le service des bains.

Les sonneries électriques sont indiquées comme devant établir des communications très-étendues et instantanées entre tous les services et en assurer à la fois le contrôle et la régularité. Des bascules pour le pesage des combustibles et des denrées reçues, des paratonnerres sur les différentes parties de l'édifice, une horloge avec cadran au fronton de la chapelle, complètent l'ensemble des travaux spéciaux à exécuter dans l'Hôtel-Dieu reconstruit.

III.—EXAMEN ET APPRÉCIATION DES PLANS ET DISPOSITIONS PROJETÉS.— Quelque effort que nous ayons fait pour donner une idée exacte des plans de reconstruction du nouvel Hôtel-Dieu, et pour justifier les propositions du Comité en fournissant à chacun les moyens de juger par lui-même, nous ne pouvons nous dispenser de revenir sur l'ensemble et sur les détails de cette grande entreprise, et avant d'en exposer les voies et les moyens, nous devons rechercher en l'examinant avec impartialité, si, au double point de vue de l'hygiène et de l'assistance publique, elle est digne de la haute approbation du conseil municipal.

Ce n'est pas à dire toutefois que nous croyons devoir donner place dans ce rapport à toutes les questions d'hygiène hospitalière ou même d'économie politique et sociale qui, directement ou indirectement, de près ou de loin, ont été agitées à propos de l'Hôtel-Dieu : nous nous sommes suffisamment expliqué à cet égard ; mais il en est quelques-unes qui, en raison soit de l'autorité avec laquelle elles ont été débattues, soit de la persistance avec laquelle elles se sont reproduites, ou encore parce qu'elles ont trouvé un écho dans le sein même des commissions ou des conseils qui entourent l'administration, ne peuvent être passées sous silence. Nous avons abordé cette étude sans parti pris, sans opinion préconçue ; il convient d'en donner la preuve en ne nous refusant pas à écouter et à peser mûrement toutes les objections, de quelque côté et dans quelque sens qu'elles se produisent.

Il est cependant une remarque préliminaire qu'on nous permettra de présenter et qui porte en elle-même plus d'un enseignement. Par une circonstance toute fortuite, et à l'occasion d'un rapport purement scientifique sur un fait de pratique chirurgicale soumis à l'Académie impériale de médecine, une discussion s'était engagée, il y a trois ans à

peine, devant cette savante compagnie, sur les résultats comparatifs des grandes opérations dans les différents hôpitaux français et étrangers, et, par suite, sur les principes généraux de l'hygiène des établissements hospitaliers. D'un autre côté, l'administration de l'assistance publique, justement émue et soucieuse de montrer qu'elle ne restait pas indifférente à cette espèce d'agitation, et qu'elle était prête à se mettre elle-même à la tête de tous les progrès, s'entourait des lumières des hommes les plus compétents parmi les médecins, chirurgiens, pharmaciens et administrateurs des hôpitaux, et se livrait à des études dont les résultats ont fourni les matériaux d'un grand ouvrage publié par M. A. Husson, directeur de l'administration générale de l'assistance publique, véritable monument élevé à la science de l'hygiène hospitalière (1). Enfin, la haute sollicitude de l'Empereur et de l'Impératrice, toujours en éveil sur ces questions d'assistance publique, et dont tous ceux qui ont eu l'honneur d'approcher Leurs Majestés ont recueilli, en toute occasion, de si touchants témoignages, se manifestait publiquement par l'institution récente près du ministère de l'intérieur d'un conseil supérieur de l'hygiène des hôpitaux. Il est résulté de ce concours, ainsi qu'on devait s'y attendre, un grand mouvement d'opinions dans lequel, à des points de vue très-divers, parfois même opposés, ont été soulevées et débattues bien des questions d'une importance incontestable ; mais en même temps bien des hypothèses et des systèmes que l'expérience n'a pas consacrés, que la science même n'a pas encore mûris. C'est dans ces circonstances singulières que les projets de reconstruction de l'Hôtel-Dieu, depuis si longtemps suspendus, sont tout d'un coup sortis de l'ombre, avec une apparence de nouveauté qu'ils

(1) A. Husson, *Étude sur les hôpitaux*. Paris, 1863.

devaient à des conditions purement éventuelles et qui ne pouvait tromper que les personnes étrangères aux longs et interminables débats qu'ils alimentaient depuis tant d'années. Il était naturel que l'entreprise fût jugée sous le coup des préoccupations abstraites et des idées théoriques qui étaient venues renouveler la question de l'hygiène hospitalière; mais il était à craindre que l'on perdît de vue du même coup la question spéciale de l'Hôtel-Dieu, et qu'ardents à poursuivre la réalisation d'un idéal encore mal défini, quelques esprits se saisissent de l'occasion, et sans s'inquiéter des nécessités pratiques auxquelles l'Hôtel-Dieu doit faire face, ne vissent dans les plans à proposer qu'un motif d'expérimentation et une matière à controverses.

L'administration de la ville de Paris ne pouvait se laisser entraîner dans cette fausse voie; ses devoirs sont tout autres: et si au moment de reconstruire un grand hôpital elle doit s'attacher à mettre à profit l'expérience acquise et à y rassembler tous les perfectionnements que lui offrent la science et l'industrie, elle ne peut à aucun prix leur subordonner les intérêts graves et urgents que le nouvel Hôtel-Dieu doit satisfaire et les conditions impérieuses que la situation actuelle de l'assistance publique lui impose. C'est à ce point de vue, moins élevé peut-être, mais plus sûr et plus vrai, que le Comité s'est placé pour examiner les plans qui lui ont été soumis et les objections que l'on a faites ou que l'on peut faire aux dispositions projetées.

Tout a été dit au sujet de l'emplacement choisi, et il serait superflu d'y revenir après ce que nous avons rappelé de l'opinion si nettement formulée et avec tant d'autorité par les médecins et chirurgiens de l'ancien Hôtel-Dieu, aussi bien que par la commission médicale récemment appelée à examiner les nouveaux projets de reconstruction de l'Hôtel-Dieu. Nous n'avons pas à relever ce qu'il y a d'excessif et d'impraticable dans cette vue qui consisterait

à reléguer les hôpitaux, non pas seulement loin du centre, mais même hors de l'enceinte des villes. Nous nous contentons de répéter que parmi les emplacements successivement proposés dans le voisinage de l'Hôtel-Dieu actuel, celui auquel on s'est arrêté réunit en réalité les meilleures conditions de salubrité générale.

Sur un point seulement l'objection subsiste: le périmètre adopté est déclaré insuffisant, eu égard au nombre de lits que doit contenir l'Hôtel-Dieu. On sait que la superficie totale est de 21 800 mètres, et il est bon de rappeler que le nombre total des lits composant l'ensemble des services de médecine, de chirurgie et d'accouchement, dont nous avons indiqué les divisions, doit être de 716. Nous ne contesterons pas que le rapprochement, ou, pour parler plus exactement, l'opposition de ces deux chiffres puisse, au premier abord, éveiller quelques appréhensions, quand on se reporte à la contenance de quelques hôpitaux dont l'étendue plus considérable ne répond cependant qu'à un moindre nombre de malades; et, bien plus encore, quand, au nom de certains principes érigés en lois absolues, on prétend fixer par avance le nombre de mètres superficiels que doit offrir, par lit, la totalité de l'emplacement destiné à un hôpital. Ces deux sortes d'objections que nous n'avons pas cherché à amoindrir, on nous rendra la justice de le reconnaître, ont entre elles une évidente connexion; et comme elles ont trouvé un écho jusque dans le conseil de surveillance de l'administration générale de l'assistance publique; comme elles sont reproduites avec une certaine insistance dans le rapport qui a précédé la délibération de ce conseil et qui fait partie des communications que nous avons reçues, nous devons les soumettre à un sérieux examen et nous demander quelle en est au fond la valeur.

La question, dans les termes auxquels on voudrait la

réduire, est assurément mal posée. Il est impossible, en effet, d'établir un rapport constant entre le nombre de mètres que comprend le périmètre d'un hôpital et le chiffre des malades qui seront placés dans les constructions de cet hôpital, et de dire, par exemple, qu'un hôpital, pour être salubre, devra présenter, au minimum, un espace superficiel équivalent à autant de fois 50 mètres carrés qu'il devra contenir de lits. La rigueur apparente de cette formule mathématique ne résiste pas à l'évidence du fait. Ne sortons pas de l'Hôtel-Dieu : aussi bien nous ne prétendons en aucune façon poser des lois, et nous nous renfermons exclusivement dans les limites du fait qui nous occupe. Mais, que l'on examine de près les choses et que l'on dise si, au point de vue de la libre aération et de l'insolation, l'Hôtel-Dieu ne bénéficie pas des larges espaces vides qui s'étendent autour de lui au nord et au midi, et s'il est juste, dès lors, de ne faire entrer dans le calcul de la superficie acquise aux malades que les 22 000 mètres enclos dans le périmètre de l'hôpital. Bien plus, n'est-il pas clair encore que, dans ce chiffre posé comme base de la proportion à établir entre la surface de l'emplacement et la population d'un hôpital, il conviendrait au moins de faire entrer en ligne de compte le rapport des espaces restés libres et de la superficie occupée par les constructions ; et que, pour l'Hôtel-Dieu, par exemple, l'établissement d'un vaste sous-sol augmente l'étendue intérieure sans diminuer l'espace extérieur de l'hôpital, et permet ainsi de donner aux malades, dans un périmètre réduit, plus de place qu'on ne leur en accorde dans d'autres hôpitaux qui occupent une plus large surface. Que devient, en présence de ces deux faits, un principe absolu, et que valent les objections qui se fondent sur ce principe ?

Mais il en est un autre plus absolu encore et qui trouve

des partisans convaincus et d'ardents défenseurs. Quelle que soit la contenance du terrain, un hôpital ne devrait pas, dit-on, dépasser un nombre de lits très-restreint et de beaucoup inférieur à celui qui est proposé pour le nouvel Hôtel-Dieu. Les uns, les plus décidés, n'en veulent pas plus de 200 à 250 ; les autres iraient jusqu'à 500 ; quelques-uns enfin, fixent à 600 la limite qu'il ne faut pas franchir. Pour les premiers, si on les suivait dans la voie où les entraîne l'exagération des plus honorables sentiments, on arriverait bien vite à la condamnation et à la destruction totale de l'assistance hospitalière, dont ils ne voient que les inconvénients sans en reconnaître les bienfaits et l'incontestable utilité. Pour les seconds, il n'y a pas à leur répondre, mais à les interroger et à leur demander pourquoi 500 lits plutôt que 600 ; pourquoi 600 plutôt que 700 ? Car nous ne saurions le dire trop haut et avec plus de conviction, ce n'est pas le chiffre total des malades admis dans un hôpital qui importe ; c'est la manière dont ils y sont placés et traités. Le danger qu'il faut redouter, c'est la viciation de l'air par l'encombrement ; et chaque jour le conseil municipal condamne des logements insalubres dans des maisons spacieuses et saines, sachant fort bien que ce n'est pas dans l'ensemble et dans le voisinage, mais dans la localité elle-même que se trouvent les causes réelles de l'insalubrité par défaut d'air et par encombrement.

Appliquons ces données au plan du nouvel Hôtel-Dieu, et il nous sera facile de montrer que le reproche qui, d'une manière générale, semble pouvoir être adressé au nombre trop élevé de 716 lits, tombe devant la distribution excellente des divers services et le fractionnement des malades, innovation heureuse que nous nous félicitons de voir introduire dans notre système hospitalier. Que l'on veuille bien se rappeler la description que nous avons donnée des par-

tés du nouvel Hôtel-Dieu qui seront occupées par des salles de différentes dimensions, on verra que les 716 lits seront répartis dans 18 salles de 26 à 30 lits, 19 salles de 6 lits, 3 de 10 à 12 lits, 44 chambres à 1 ou à 2 lits, en tout 84 pièces séparées, dont le cubage dépasse les proportions admises jusqu'ici dans les établissements les plus favorisés, et où la ventilation artificielle peut porter le renouvellement de l'air au-dessus de 100 mètres cubes par heure et par lit. Ainsi, en résumé, l'élévation du nombre est corrigée par le fractionnement des lits, et l'encombrement général est combattu par l'isolement particulier des malades. 828 malades remplissent aujourd'hui sans aggravation de la mortalité l'ancien Hôtel-Dieu, dont la superficie ne dépasse guère 12 ou 13 000 mètres et que personne ne songe à défendre; 716 malades, dans des conditions exceptionnelles de salubrité, peuvent bien trouver place dans les 22 000 mètres du nouvel Hôtel-Dieu.

Il existe d'ailleurs une disposition particulièrement favorable et toute nouvelle sur laquelle il est bon d'insister. Outre les lits permanents qui forment l'ensemble des services réguliers et qui sont au nombre de 716 84 lits réservés dans les combles des deux bâtiments latéraux de la cour centrale, répartis en 10 salles, serviront à établir une sorte d'alternance dont l'influence hygiénique n'a pas besoin d'être longuement démontrée, et ne seront occupés que d'une manière passagère, lorsqu'il se fera dans quelques-unes des autres parties de l'hôpital un vide correspondant. C'est de cette manière que l'on arrive à un chiffre total de 800 lits; mais avec cette circonstance capitale et bien digne d'attention que les 84 lits de rechange, loin d'ajouter au nombre réel des malades que renfermera le nouvel Hôtel-Dieu, viennent au contraire alléger et défendre contre les effets de l'encombrement les services réguliers qui reste-

ront invariablement fixés au nombre précédemment indiqué (1).

Si nous avons repoussé si formellement la réduction du nombre des lits posée en principe comme une loi de l'hygiène hospitalière, c'est qu'il nous est impossible de trouver dans ces affirmations le caractère de déductions vraiment scientifiques, et que nous ne saurions en aucun cas consentir à fonder sur des données aussi arbitraires les résolutions du conseil municipal et les desseins de l'administration de la ville de Paris. Ce n'est pas, avons-nous besoin de le répéter, que nous nous dissimulions la gravité des questions soulevées; mais à ces questions nous voulons des solutions positives, et non des objections de sentiment. Pour qu'il ne reste aucun doute à cet égard, qu'on nous permette d'insister encore.

Il y a dans la construction d'un hôpital des convenances que personne, aujourd'hui, ne songerait à nier, mais que l'on est porté à exagérer au delà de toute raison. Le nombre des étages superposés, la contiguïté des salles ou des bâtiments doivent, cela est certain, être l'objet d'une attention particulière; mais il ne s'ensuit pas que l'on doive regarder dans un hôpital, d'ailleurs bien disposé, un second étage comme notoirement plus insalubre que le rez-de-chaussée, et que l'on doive mettre entre chaque salle et chaque bâtiment des intervalles véritablement disproportion-

(1) Le tableau suivant donne la distribution exacte des malades dans les différentes parties de l'hôpital :

Rez-de-chaussée,	224 lits,	26 salles (grandes ou petites) et chambres.
1 ^{er} étage.....	234	27
2 ^e étage.....	258	31
	716	84
Services de rechange.	84	10
	800	94

tionnés et dont il serait d'ailleurs bien rare que l'on puisse disposer. Pour l'Hôtel-Dieu, à cet égard les plans primitifs n'avaient pas paru tout à fait satisfaisants; et, sur les observations de la commission médicale, M. le préfet ayant autorisé de nouvelles études, l'avant-projet actuel a réalisé dans la mesure du possible des dispositions qui suffisent pour éviter la trop grande contiguïté et l'élévation exagérée des pavillons transversaux occupés par les malades. Ceux-ci ont été abaissés d'un étage, et la largeur des préaux qui les séparent a été portée de 30 mètres à 37 mètres 50; la lumière et l'air joueront librement dans cet espace. Quant à la cour centrale, si elle reste encore moins spacieuse qu'on ne serait tenté de le désirer, il convient de faire remarquer qu'elle est ouverte au midi par le peu d'élévation de la partie correspondante de la façade sur la place du Parvis; et que, dans toute sa longueur, règne un double étage de galeries ouvertes qui en augmente la largeur. Enfin, chose plus importante encore, on ne doit pas oublier qu'aucune des grandes salles de malades ne prend jour sur cette cour centrale où s'ouvrent seulement les petites chambres à 1 ou à 6 lits, les offices, les salles de réunions et autres services particuliers, pour lesquels l'espace laissé libre entre les deux bâtiments longitudinaux qui bordent la cour est certainement suffisant.

Nous ne voulons pas terminer ce qui touche les objections générales faites au projet du nouvel Hôtel-Dieu, sans faire observer qu'elles émanent, non pas, comme on affecte de le faire croire, du corps médical tout entier, ni même des médecins des hôpitaux, mais presque exclusivement des chirurgiens, et sont motivées uniquement sur les différences que présenteraient les résultats des grandes opérations dans la pratique urbaine comparée à la pratique nosocomiale, dans les différents hôpitaux entre eux, ou encore à la ville et à la campagne. Ces différences, en

admettant qu'elles ressortent d'une manière positive des statistiques invoquées et qu'elles ne tiennent pas à d'autres causes qu'à l'influence directe et exclusive de l'hôpital, ce qui n'est nullement démontré, seraient certainement de nature à émouvoir non-seulement les chirurgiens eux-mêmes mais encore les administrateurs de l'assistance publique; mais il est impossible de ne pas considérer que, dans son ensemble, l'hôpital a une bien autre destination que la chirurgie active, et que les nombreuses maladies internes et externes qui n'exigent pas d'opérations, trouvent dans les conditions de l'assistance hospitalière, et surtout dans les perfectionnements que l'on réalisera par l'exécution des plans du nouvel Hôtel-Dieu, des garanties de secours et de guérison aussi assurées que possible. Il en est un d'ailleurs qui, il est permis de l'espérer, se fera sentir même pour les opérés, et atténuera dans l'avenir les oppositions anticipées que l'Hôtel-Dieu a soulevées avant de naître au sein de la Société de chirurgie. Nous voulons parler de ces petites salles et de ces chambres à un lit qui, établies en grand nombre dans l'hôpital, permettront pour la première fois d'instituer sur une grande échelle l'isolement et le traitement à part des pauvres malades qui auront subi de grandes opérations. La statistique médicale depuis quatre ans déjà est établie dans les hôpitaux de Paris; seule elle apportera un jour la lumière dans ces questions encore si obscures, et dissipera cette confusion contre laquelle nous ne cesserons de protester. Nous l'avons dit ailleurs, la mortalité n'est pas la mesure de la salubrité d'un hôpital; et il ne serait pas d'une sage administration de subordonner les bienfaits de l'assistance hospitalière aux chances incertaines de la mort qui ne sont pas et ne seront jamais dans les mains de l'homme.

Nous en avons fini avec les objections que l'on peut, à bon droit, appeler principales, et il ne nous reste plus qu'à

passer en revue les dispositions de détail du nouvel Hôtel-Dieu, sur lesquelles nous aurons à présenter chemin faisant quelques observations.

Le service d'accouchement mérite de notre part un examen spécial. Le conseil général de la Seine, dans sa dernière session, a manifesté, par un vœu formel, l'intérêt qu'il attachait à l'amélioration du système d'assistance en matière d'accouchement. M. le préfet s'est associé à ce vœu en faisant connaître les vues de l'administration et les progrès accomplis déjà dans cette voie. Le conseil municipal n'a rien oublié de cette grave discussion et est resté très-frappé des avantages incontestés qu'offre pour les femmes en couches le traitement à domicile. Il ne s'ensuit pas qu'il soit possible de supprimer dès à présent les accouchements dans les hôpitaux; mais tout commande de réformer l'économie générale des maternités, de diviser les services d'accouchement et de les établir dans des conditions particulières de salubrité. Le nouvel Hôtel-Dieu offre à cet égard des dispositions bien entendues. Le service d'accouchement y est distinct du reste de l'hôpital et occupe, dans ce que nous avons appelé l'avant-corps, quatre salles de 10, 2, 4 et 6 lits, disposées autour de la terrasse qui domine la cour d'entrée. Il est toutefois une particularité que notre savant président a fait remarquer au comité, et que, d'accord avec lui, nous signalons comme essentiellement défectueuse. Au-dessous de l'une des salles d'accouchement se trouve une petite salle affectée à la chirurgie et indiquée comme devant former une annexe du service des opérés. Il convient d'éviter ce rapprochement et de maintenir l'isolement complet des femmes en couches, ce qui sera on ne peut plus facile en réunissant cette salle de 40 lits au service d'accouchement au lieu de la rattacher à la chirurgie ou même à la médecine.

Nous avons cherché vainement dans les détails de l'avant-

projet une disposition qui assure la séparation complète et forcée des malades atteints de variole. Nous savons que cette précaution indispensable, conseillée déjà par Tenon en 1780, réclamée récemment encore avec énergie par l'unanimité des médecins des hôpitaux et si admirablement réalisée à Londres par l'établissement du *Small-pox Hospital* (1), est décidée en principe par l'administration de l'assistance publique. Mais il faut que, dans le nouvel Hôtel-Dieu, les conditions matérielles nécessaires à cette mesure d'humanité soient clairement et formellement étudiées et prévues. Les salles de 6 lits et les chambres à 1 lit, annexées à chaque service médical, très-bonnes pour les cas exceptionnellement graves, seraient absolument insuffisantes et inefficaces pour isoler du reste de l'hôpital le service des varioleux, seul moyen de combattre et de détruire dans son germe cette funeste contagion.

Sous le bénéfice de ces réserves, tout est à louer dans les plans du nouvel Hôtel-Dieu, dont nous avons donné une description qui nous dispensera de plus longs développements. Les services généraux, les appropriations spéciales à un hôpital d'enseignement, la distribution du sous-sol, les abords et dégagements, les dépendances des salles de malades, lavabos, bains, offices, salles de réunion, les bureaux d'admission annexes de l'administration centrale, enfin les lieux consacrés au culte de la religion et à la mort, tout dans les projets soumis à l'approbation du conseil révèle la connaissance approfondie, l'étude consci-

(1) Aucun hôpital à Londres n'admet les malades atteints de petite vérole. Ceux-ci, à moins de grande épidémie, sont exclusivement dirigés sur *Small-pox Hospital*, établi dans une situation admirable à 4 milles du centre de la ville. Le résultat de cet isolement absolu des varioleux est tel, et l'influence qu'il exerce sur la diminution des cas de petite vérole est si grande, qu'il en existait au 1^{er} seulement dans l'hôpital spécial et pas un dans les vingt autres grands hôpitaux de Londres au moment où nous les avons visités.

ciense, l'entente parfaite des besoins à satisfaire, des difficultés à vaincre, des ressources à employer et des perfectionnements à introduire dans la construction du nouvel Hôtel-Dieu. Nous ne craignons pas d'être démenti en proclamant que, dans aucun des hôpitaux de la France ou de l'étranger dont les dispositions nous sont connues, on ne trouvera un ensemble aussi bien entendu et une aussi remarquable application de la science et de l'art de l'architecte à l'hygiène et à la construction d'un grand hôpital.

Nous n'ajouterons que quelques mots concernant les travaux spéciaux qui doivent compléter l'Hôtel-Dieu reconstruit. Les monte-charges et chemins de fer, les sonneries électriques, l'éclairage au gaz, l'emmagasinement et la distribution des eaux constituent des améliorations réelles qu'il suffit de citer et sur lesquelles nous n'avons rien à ajouter. Il n'est rien dit des modèles qui seront adoptés dans les cabinets d'aisances ni de la construction des fosses; nous savons que nous pouvons nous en rapporter à la vigilance de l'administration à ce sujet; mais nous ne pouvons passer sous silence des objets si importants pour la salubrité d'un hôpital.

Quant aux systèmes de chauffage et de ventilation proposés, il y a lieu d'insister sur quelques points. Nous avons pris soin de les faire connaître dans leurs principaux détails et d'indiquer déjà les motifs généraux de la préférence qui leur a été accordée. Nous comprenons et nous avons fait ressortir les nécessités auxquelles il est impossible de se soustraire dans le choix et la construction des appareils destinés à chauffer et à ventiler un établissement aussi considérable et d'une nature aussi particulière que celui dont il s'agit. Nous ne sommes donc nullement tenté de méconnaître ces nécessités ou de les subordonner à des réserves trop restrictives; nous nous bornerons à quelques remarques.

La supériorité hygiénique des foyers découverts a été reconnue par l'habile ingénieur à qui sont dues les études destinées au nouvel Hôtel-Dieu; mais peut-être en a-t-il trop réduit l'emploi en l'appliquant seulement aux salles de réunion des convalescents; et l'on peut se demander pourquoi il n'a pas cherché à en utiliser l'influence salubre dans les chambres à un lit, dans quelques-unes des petites salles et même dans le service des femmes en couches. En tout le reste, le système de chauffage combiné à l'eau chaude et à la vapeur ne présente que des avantages et réunit les meilleures conditions de commodité, d'économie et de salubrité.

Quant à la ventilation, si nous sommes disposé à réclamer un emploi plus large et plus fréquent de la ventilation naturelle; si nous exprimons hautement le désir de voir s'introduire dans nos hôpitaux l'usage si répandu en Angleterre de donner le plus souvent et le plus longtemps possible par les fenêtres et les portes ouvertes un libre accès à l'air extérieur dans les salles de malades; si nous réclamons à cet effet dans la construction du nouvel Hôtel-Dieu une disposition convenable des fenêtres et l'établissement de châssis mobiles que nous n'avons vu indiqués ni dans les plans, ni dans le mémoire de l'ingénieur, et dont les modèles sont cependant figurés dans l'*Étude sur les hôpitaux*, publiée par M. le directeur de l'administration de l'assistance publique, nous convenons pourtant qu'il n'est pas possible de ne pas assurer le renouvellement de l'air dans les salles de malades et de ne pas pourvoir à l'assainissement de leurs diverses dépendances à l'aide d'une ventilation artificielle. Les systèmes qui, depuis tant d'années, se combattent, et qui, expérimentés à si grands frais à l'hôpital Lariboisière, ont été, chacun de son côté, l'objet de critiques et d'apologies également exclusives, vont se trouver réunis et combinés dans le nouvel Hôtel-Dieu. L'emploi simultané d'une machine à propulsion qui introduira dans

les salles l'air neuf pris hors de l'hôpital, et d'un appel rendu plus énergique par l'élévation de la température dans les cheminées d'évacuation, doit concilier les avantages des deux systèmes et faire tomber les objections qui avaient été opposées isolément à chacun d'eux. De l'expérience est née la conciliation, et il est permis de considérer ce système mixte comme la solution définitive du problème complexe de la ventilation artificielle. Le nouvel Hôtel-Dieu profitera de ce progrès de la science d'une manière d'autant plus sûre et d'autant plus heureuse, que toutes les dispositions mécaniques, physiques et économiques de cette ventilation nouvelle sont étudiées et prévues avec tout le soin possible et une connaissance profonde de ces difficiles travaux.

Nous en avons dit assez pour mettre le conseil à même de juger, ainsi que nous en avons pris l'engagement, de la valeur des objections qui ont été dirigées contre les plans du nouvel Hôtel-Dieu, pour lesquels nous n'hésitons pas, après l'examen auquel nous venons de nous livrer, à solliciter presque sans réserve sa haute approbation.

IV. — (La quatrième partie du Rapport est consacrée à l'exposition des voies et moyens d'exécution du nouvel Hôtel-Dieu. Il serait sans intérêt pour les lecteurs des *Annales* de la reproduire, nous en extrayons seulement l'indication de travaux nombreux et importants que se propose d'entreprendre l'administration de l'assistance publique et auxquels l'avenir devra pourvoir.)

Ce programme est de nature à frapper vivement le conseil; dû à l'initiative de M. le directeur de l'administration de l'assistance publique, il résume, en effet, dans un tableau saisissant, les besoins des établissements hospitaliers de Paris, les études incessantes dont ils sont l'objet et les améliorations qui, dans un avenir prochain, devront être réalisées en faveur des classes pauvres de la capitale.

Nous ne pouvons nous dispenser d'en donner ici un aperçu : la création de deux nouveaux hôpitaux pour les adultes, de 500 lits chacun, et d'un hôpital pour les enfants, également de 500 lits, sur le bord de la mer; l'achèvement et la reconstruction partielle des hôpitaux déjà existants : la Pitié, Saint-Antoine, Cochin, Beaujon, Saint-Louis, le Midi, Lourciné, les Enfants malades, Sainte-Eugénie et la Maternité; la création de services spéciaux d'accouchement dans les dépendances de plusieurs hôpitaux ou hospices et de maisons spéciales destinées à recevoir des femmes en couches, si, malgré les efforts commencés pour augmenter les accouchements à domicile, il devient nécessaire d'ouvrir de nouveaux locaux avec alternance pour diviser les groupes; l'établissement de pavillons isolés pour les malades atteints d'affections contagieuses à Necker, Saint-Antoine, Lariboisière et Beaujon; l'assainissement et la réorganisation de tous les appareils spéciaux et des services de salubrité des divers établissements; certains travaux d'achèvement ou d'agrandissement dans les hospices à Bicêtre, à la Salpêtrière, à la Rochefoucauld et à Forges-les-Bains, tel est l'ensemble considérable des travaux à entreprendre pour donner à l'assistance hospitalière dans la ville de Paris tous les développements et toute la grandeur qu'elle comporte. Le conseil municipal, qui en comprend toute l'importance, n'hésitera jamais à voter les fonds que M. le sénateur, préfet de la Seine, lui demandera pour en hâter l'exécution. Aussi ne refusera-t-il certainement pas de ratifier l'engagement pris au nom de la ville de Paris, de ne pas laisser l'administration de l'assistance publique se dépourvoir et de l'aider dans la mesure de ses besoins à exécuter le vaste programme qui vient d'être exposé.

Les diverses propositions contenues dans le présent rap-

port ont été approuvées par le conseil municipal et ont servi de base à la délibération suivante :

DÉLIBÉRATION DU CONSEIL MUNICIPAL.
Séance du 24 mars 1865.

LE CONSEIL,

Vu le mémoire, en date de ce jour, par lequel M. le sénateur, préfet de la Seine, lui soumet un projet de reconstruction des bâtiments de l'Hôtel-Dieu sur un terrain circonscrit par la place Notre-Dame et le quai Napoléon, d'une part, la rue d'Arcole et la rue de la Cité, d'autre part ;

Vu l'avant-projet des travaux de construction rédigé par M. Diet, architecte, et par M. Ser, ingénieur de l'administration générale de l'assistance publique, dont la dépense est évaluée à la somme totale de 12 419 627 fr. 21 c. ;

Vu l'avis du conseil de surveillance de l'assistance publique en date du 23 mars 1865 ;

Vu le rapport du directeur de cette administration ;

Après avoir entendu le rapport présenté au nom du comité n° 3 ;

Considérant, d'une part, que le projet est bien conçu ; qu'il présente un ensemble de dispositions parfaitement combinées et qui satisfont à toutes les exigences, au double point de vue de la salubrité et de la commodité des services ;

Considérant, d'autre part, qu'il résulte des divers documents produits, que l'ensemble de la dépense, spécialement applicable à la reconstruction de l'Hôtel-Dieu et relative tant à l'expropriation des immeubles qu'aux travaux et à l'acquisition du matériel, peut être évalué approximativement à 21 400 000 fr. ;

Délibère :

ART. 1^{er}. — Il y a lieu d'approuver l'avant-projet des travaux relatifs à la reconstruction des bâtiments de l'Hôtel-Dieu sur un terrain circonscrit par la place Notre-Dame et

le quai Napoléon, d'une part, par la rue de la Cité et la rue d'Arcole, d'autre part, avant-projet dont la dépense est évaluée au chiffre de 12 419 627 fr. 21 c.

ART. 2. — Conformément à la délibération prise par le Conseil de surveillance de l'administration de l'assistance publique dans sa séance du 23 de ce mois, il y a lieu, par cette administration, d'appliquer aux dépenses relatives à la reconstruction de l'Hôtel-Dieu, tant pour l'expropriation des immeubles que pour les travaux et le matériel nécessaires, les ressources ci-après indiquées, savoir :

1^o Le capital de la dette contractée par la ville de Paris vis-à-vis de l'administration hospitalière, dette qui n'avait été stipulée remboursable qu'en 1874, et que la ville de Paris s'engage à faire payer à l'administration de l'assistance publique au fur et à mesure des besoins de l'opération dont il s'agit, ci. 12 330 528 90

2^o Le prix des terrains et des bâtiments que l'administration de l'assistance publique devra céder à la ville de Paris dans la Cité, pour la formation des abords de Notre-Dame, et que la ville de Paris s'engage à faire verser, au fur et à mesure des besoins, dans la caisse de l'administration de l'assistance publique, aussitôt qu'il aura été réglé entre les deux administrations ; ledit prix évalué provisoirement à. 4 800 000 »

3^o Le bénéfice, quel qu'il soit, à provenir de la vente des terrains et bâtiments de l'ancienne institution de Sainte-Périne et des anciens hospices des Ménages et des Incurables, estimé sommairement à. 2 500 000 »

Total par évaluation. 19 630 528 90

ART. 3.— La ville de Paris supportera seule toute la partie des dépenses d'établissement, de construction et d'installation du nouvel Hôtel-Dieu, et toutes celles relatives aux indemnités d'expropriation des immeubles à acquérir pour la formation du périmètre de l'hôpital qui excéderont le montant des ressources fournies par l'administration hospitalière et qui sont indiquées ci-dessus, et ce, indépendamment des dépenses relatives aux opérations de voirie qui resteront de même et exclusivement à la charge de la ville.

ART. 4.— Le Conseil, en conformité du vœu exprimé par le conseil de surveillance de l'administration de l'assistance publique, se réserve de déterminer ultérieurement le concours que la ville de Paris devra fournir dans les dépenses des travaux qui restent à exécuter par cette administration pour compléter l'amélioration des services hospitaliers.

PROJET

D'HOPITAL MILITAIRE.

Les formalités exigées par la loi ont été remplies.

PROJET

D'HOPITAL MILITAIRE

PAR

F.-P.-J. PIRON,

CAPITAINE DU GÉNIE.

BRUXELLES. — GAND. — LEIPSIG.
C. MUQUARDT.
—
1865

AU LECTEUR.

Ces études sur un projet d'hôpital militaire ne peuvent être mieux justifiées qu'en citant les lignes suivantes du *Cours d'Art Militaire* du major du génie Laurillard-Fallot (29^e leçon, 3^e partie) :

« Le bâtiment militaire qu'on classe d'ordinaire le second dans
« l'énumération des locaux indispensables et qu'on devrait nommer
« le premier, est l'hôpital.
« En effet, si un repos assuré est nécessaire à l'homme valide,
« qui ne souffre que de la fatigue, combien plus le sera-t-il à celui
« que les blessures et la maladie affaiblissent! Et à la rigueur, le
« soldat bien portant peut chercher loin des fronts attaqués des
« endroits moins exposés à l'atteinte des projectiles, il peut chan-
« ger de gîte à mesure que le péril se rapproche de lui, tandis que le
« blessé, forcé de rester à la place où on l'a déposé, quelque dan-
« gereuse qu'elle puisse être, ne peut éviter ni prévenir le mal qui
« le menace. Ceci est bien évident, bien palpable et cependant je
« ne connais aucune place forte dans laquelle il existe un hôpital
« de siège suffisant et proportionné à la force de la garnison.
« C'est une de ces négligences dont on ne reconnaît les funestes
« effets que lorsqu'il est trop tard pour y remédier et qui, motivées
« par de prétendues raisons d'économie, est un véritable scandale
« pour l'humanité. »

Cette critique acerbe, écrite en 1859 par un militaire aussi expérimenté que savant, est encore applicable en 1865. Pourquoi? Parce que les économistes considèrent les dépenses militaires comme étant improductives, et qu'ils n'accordent qu'avec parcimonie l'argent nécessaire pour assurer la défense nationale.

L'économie, dans ce cas, devient de l'avarice et cet état des choses est d'autant plus regrettable que les dépenses militaires sont plus grandes; car la parcimonie sur un point peut rendre illusoire les armements les plus coûteux.

En effet, il ne suffit pas, pour être à même de combattre, de posséder une armée, des forteresses et des arsenaux; il faut y joindre les moyens propres à assurer l'état sanitaire des troupes.

S'il est vrai que l'argent est le nerf de la guerre, il n'est pas moins certain que la santé du soldat fait la force des armées.

Sans la santé, on ne peut compter sur le courage des hommes; et quand les combattants sont décimés par les maladies, la force morale tombe et les corps sont bientôt désorganisés.

Pour éviter de semblables calamités, que faut-il? Un service sanitaire largement et généreusement constitué. Mais, dans une place forte, il ne suffit pas d'avoir un grand nombre d'officiers de santé et une ambulance bien organisée, il faut « un hôpital pouvant contenir « un sixième de la garnison outre tout ce qui est nécessaire au service de santé. » (FALLOT.)

Il faut que tous les hommes malades puissent recevoir immédiatement les soins que réclame leur état, sous peine de voir s'aggraver les maladies et la mortalité affaiblir l'effectif.

Combien d'hommes sont morts faute de soins et qui eussent été sauvés s'ils avaient pu passer quelques jours dans un hôpital bien organisé! Car beaucoup d'indispositions ne deviennent graves que parce qu'elles ne sont pas soignées à leur début; et souvent, aussi, parce que l'encombrement d'un hôpital trop petit empêche d'y admettre tous les hommes dont la santé exige un prompt remède.

Les officiers qui ont fait la guerre savent que les maladies font plus de tort aux armées que le feu de l'ennemi. En campagne, il est difficile, sinon impossible, de donner aux hommes tous les soins que leur position réclame.

Mais dans les places fortes assiégées, on pourrait aisément établir des hôpitaux capables de satisfaire complètement au service sanitaire.

On devrait donc y pourvoir en temps de paix. Il est vrai qu'au moment de la guerre on utilise les bâtiments civils et religieux; mais comme ils ne satisfont pas aux convenances d'un hôpital, les hommes s'y trouvent dans des conditions hygiéniques déplorable qui favorisent le développement des épidémies et augmentent la mortalité.

Et cependant, c'est dans la défense des places que l'on devrait le plus s'occuper de la santé du soldat; si

ce n'est par humanité, au moins parce que c'est un moyen de conserver des défenseurs qui font défaut à la fin d'un siège.

L'encombrement et son triste cortège seront bien plus à craindre encore dans les grandes places et dans les camps retranchés destinés à servir de dépôt et de refuge aux armées modernes. C'est là surtout que se révélera la culpabilité de ceux qui, par une économie déraisonnable, auront empêché la création d'établissements sanitaires proportionnés aux besoins d'une armée qui devra combattre longtemps pour la défense d'un grand pivot stratégique.

Car, ces grandes places de guerre auront désormais une influence décisive sur le sort des Etats. Elles seront le théâtre des luttes les plus longues et les plus terribles contre les armées ennemies. Les nombreuses troupes qui y seront concentrées engageront chaque jour des combats à la suite desquels les ambulances regorgeront de blessés.

Et comme la défense d'un camp retranché peut durer des mois et même des années, on conçoit que le nombre des blessés et des malades s'accroisse en proportion de l'effectif de l'armée et en raison de la durée du siège.

Si, dans ce cas, l'armée était privée des établissements sanitaires dont l'urgence ne peut être mise en doute, le sort des blessés et des malades serait désespéré; la plupart mourraient, tandis qu'avec des soins ils auraient pu guérir et reprendre leur place sous les armes.

D'ailleurs, ne sait-on pas combien l'encombrement présente de dangers. Il engendre la pourriture d'hôpital, la fièvre typhoïde, le choléra, la peste, etc.

En outre, ces terribles maladies ne se contentent pas des tristes victimes qu'elles dévorent dans les hôpitaux; ces épidémies empoisonnent l'air et s'attaquent aux hommes valides; elles épuisent les populations et anéantissent les corps.

Il est évident que dans de telles conditions, la défense ne pourrait être bien longue, et que ce serait en vain que l'on compterait sur l'efficacité des fortifications, sur le génie des généraux et sur la valeur des troupes.

Ce qui précède démontre qu'il y a lieu d'étudier sérieusement la question des hôpitaux à établir dans les grandes positions militaires.

Cette question, du reste, fut peu traitée; parce que l'idée d'une défense concentrée est peu ancienne, et que la plupart des hôpitaux militaires sont établis dans les vieux couvents ou d'autres édifices appartenant aux domaines.

En outre, l'organisation du service de santé dépend de questions d'architecture, d'hygiène et d'administration non résolues jusqu'ici, et pour la solution desquelles doivent concourir les officiers du génie, du service de santé et de l'intendance.

Nous ne croyons pas avoir résolu le problème des hôpitaux militaires; mais nous pensons que nos études peuvent contribuer à éclairer les difficultés qu'il pré-

sente. C'est pourquoi nous soumettons nos idées au jugement et à l'expérience de nos camarades.

F.-P.-J. PIRON.

Anvers, le 8 février 1865.

PREMIÈRE PARTIE.

CHAPITRE I^{er}.

Importance et conditions générales que comporte l'hôpital militaire d'un grand pivot stratégique.

EFFECTIF DE L'ARMÉE DE LA DÉFENSE.

Dans l'hypothèse d'une vaste enceinte précédée d'un camp retranché, la défense doit avoir lieu par des troupes nombreuses qui peuvent se diviser comme suit :

La garnison de l'enceinte;

Les garnisons des forts du camp retranché;

Le corps d'armée mobile qui manœuvre et combat sous la protection des ouvrages.

L'enceinte servant de réduit à la position, c'est à l'intérieur de l'enceinte que se trouveront les dépôts, les magasins, les ressources de toutes espèces et, par conséquent, l'hôpital militaire central où seront amenés les blessés et les malades de tous les points occupés par la défense.

Nous supposons que l'effectif des troupes concentrées dans ce camp retranché soit de 60,000 hommes de toutes armes, y compris les officiers. L'hôpital à créer sera donc proportionné à ce nombre de défenseurs et assez vaste pour abriter les blessés et les malades qui recevront des soins en même temps.

Selon Fallot, l'hôpital militaire doit pouvoir contenir $\frac{1}{3}$ de la garnison complète. « Cette prescription repose sur la « donnée expérimentale, que dans un siège régulier, la « garnison perd un tiers de sa force par le feu et les « maladies, et que la moitié de ces hommes entrent à « l'hôpital. »

L'hôpital devrait ainsi pouvoir contenir 40,000 hommes. Mais nous ne croyons pas que la défense d'un camp retranché puisse être, sous ce rapport, comparée à celle d'une place forte ordinaire.

D'après l'*Aide-Mémoire* de Laisné, (4^e édition), « on peut « admettre comme évaluation moyenne que $\frac{1}{10}$ de la « garnison se trouvera simultanément dans les hôpitaux; et « l'on disposera d'avance pour ce nombre d'hommes, des « locaux convenables dans les bâtiments situés autant que « possible dans le quartier de la place la plus éloignée des « attaques présumées.

Les deux auteurs que nous citons ne sont pas d'accord, et comme il ne nous est pas possible de professer une opinion personnelle à ce sujet, n'ayant pas l'expérience de la guerre, nous pencherons vers la citation la plus économique en admettant le dixième de l'armée, ou 6,000 hommes, pour le nombre de malades et de blessés qui se trouveront en même temps à l'hôpital.

CHOIX DE L'EMPLACEMENT.

Dans une petite place forte, il est nécessaire que tous les bâtiments soient voûtés ou blindés à l'épreuve de la bombe.

Mais dans le cas d'une grande enceinte dont le rayon a plusieurs kilomètres, cette précaution devient inutile, car il s'y trouvera toujours des espaces de terrain assez éloignés des attaques pour n'avoir pas à redouter les feux de l'ennemi. On choisira donc un espace libre d'une étendue suffisante pour procurer les cours et les promenades indispensables à un établissement d'une grande importance.

Il faut, en outre, que l'hôpital militaire soit éloigné des quartiers populeux et des endroits malsains, afin que l'air y soit pur et qu'aucune influence délétère ne soit préjudiciable à la faible santé de ses habitants. Enfin on évitera le voisinage des édifices ou des constructions élevées, susceptibles de jeter de l'ombre sur les bâtiments ou d'empêcher les vents de balayer les rues et les promenades de l'hôpital.

CONDITIONS ESSENTIELLES.

En lisant le *Cours d'Art Militaire* du major Laurillard Fallot, nous voyons que les conditions essentielles pour l'établissement d'un hôpital militaire sont : « que les salles « doivent recevoir l'air et la lumière des deux côtés; que « toute communication entre les malades et le dehors soit « rendue impossible; que le bâtiment soit orienté Nord-Sud « et que les salles contiennent assez d'air respirable pour « qu'il ne faille pas incessamment en renouveler une partie « et établir un courant d'air préjudiciable à la santé débile « des habitants. Les latrines doivent être assez éloignées pour « que l'odeur ne puisse pas gêner les malades, et cependant

« assez à portée pour que la faiblesse ne les empêche pas de s'y transporter.

« Un hôpital doit, enfin, offrir des promenoirs couverts et d'autres où les convalescents respirent l'air extérieur. »

Pour la facilité des malades et pour rendre le service plus commode, un hôpital ne devrait avoir qu'un étage au-dessus du rez-de-chaussée. Mais, alors, l'étendue occupée par les bâtiments exigerait un terrain beaucoup plus vaste. Et comme il s'agit ici d'établir le projet d'un hôpital pouvant contenir 6,000 hommes, on reconnaît la nécessité de prévoir deux étages et de disposer les combles de façon à en former un troisième étage destiné au logement des malades les moins affaiblis.

Les hygiénistes portent à 20 mètres cubes la quantité d'air nécessaire par malade. (LAISNÉ.) Des chimistes ont calculé que chaque homme absorbe l'oxygène de 29 mètres cubes d'air; on n'est pas même bien sûr que cette quantité soit suffisante, d'autres savants l'ayant portée à 45 mètres cubes. (FALLOT.)

Évidemment il ne s'agit ici que de la quantité d'air considérée comme la part dont chaque individu dispose dans une salle ventilée, et comme l'espace nécessaire aux conditions hygiéniques du logement.

Nous reviendrons sur ce sujet à l'article de l'aérage des salles.

DIMENSIONS DES SALLES. — DISPOSITIONS ET ÉTENDUE D'UN HÔPITAL POUR 6,000 HOMMES.

En comptant une moyenne de 30 mètres cubes d'air par homme, et en donnant 5 mètres de hauteur aux salles, il faudrait 6 mètres carrés par lit. Mais en tenant compte de l'espace occupé par le mobilier et la nécessité de pouvoir circuler sans entrave, nous accorderons 8 mètres carrés par homme.

Les lits étant espacés de 2 mètres de milieu en milieu, il restera 1^m 10 à 1^m 20 dans les intervalles selon qu'on leur donnera 0^m 90 ou 0^m 80 de largeur.

Pour deux rangs de lits, il faudra 8 mètres de largeur de salle, et il restera au milieu un vide d'environ 4 mètres pour la circulation.

Si l'on dispose 4 rangs de lits parallèlement, la salle aura 16 mètres de largeur. On pourrait alors former trois ruelles de 2^m 67 de largeur entre les rangs.

Ces dispositions donnent 8 mètres carrés par homme pour une longueur de salle de 2 mètres, et cet espace répond à 30 mètres cubes d'air par lit.

En plaçant 25 lits par rang, une salle de 16 mètres de largeur contiendrait 100 hommes et celle de 8 mètres de largeur servirait pour 50 malades.

D'après l'évaluation ci-dessous, 100 hommes occuperont une surface de 800 mètres carrés.

Si l'on forme un bloc de bâtiment pouvant contenir 100 hommes au rez-de-chaussée, au 1^{er} et au 2^e étage ainsi que dans les combles, ce bloc contiendrait 400 hommes. Ajoutant 200 mètres carrés pour les corridors, les escaliers, les latrines et les locaux exigés pour le service, on trouve que pour loger 400 hommes, il ne faut pas moins de 1000 mètres carrés.

Parmi les 6,000 malades ou blessés qui doivent trouver place à l'hôpital, il faut déduire environ 250 officiers qui seront logés dans des bâtiments particuliers. Il reste donc à créer des salles pour suffire à 5,750 hommes.

Si pour 400 hommes il faut 1,000 mètres carrés, pour 5,750 il faudra une surface de

$$\frac{1000 \times 5750}{400} = 14375 \text{ mètres carrés.}$$

C'est-à-dire 14 blocs au moins.

Les salles devant être orientées Nord-Sud et recevoir la lumière des deux côtés, on disposera les bâtiments de manière à former des rues parallèles qui seront balayées par les vents d'Est et d'Ouest.

On pourrait, il est vrai, adopter pour grouper les bâtiments : le carré, le rectangle, le cercle ou un autre polygone donnant une cour intérieure. Mais alors l'orientation serait défavorable et la cour intérieure, entourée de bâtiments élevés, ressemblerait à un puits dont l'air ne peut être renouvelé. (Pl. 1, fig. 1, 2, 3, 4.)

La forme rayonnante (fig. 3.) pourrait aussi être préférée comme donnant des facilités pour grouper au centre tous les locaux nécessaires au service. Mais l'orientation laisserait également à désirer.

D'ailleurs, il est une raison qui prime toutes les autres et qui fait préférer les blocs de bâtiments parallèles et séparés par des rues. C'est qu'une épidémie peut sévir dans une partie de l'hôpital et respecter les autres, si elles sont éloignées du bâtiment infecté et si l'atmosphère environnante est suffisamment renouvelée.

Dans le cas contraire, si tous les bâtiments ne forment qu'un ensemble de constructions reliées entre elles, tout le bâtiment peut être envahi par la contagion.

Nous avons trouvé que la surface occupée par les bâtiments nécessaires au logement de 5,750 malades est de 14,375 mètres carrés. Les rues qui doivent séparer les blocs et permettre la circulation des voitures auront, y compris les trottoirs, 20 mètres de largeur.

Le calcul de la surface occupée donne 41,328 mètres carrés, c'est-à-dire plus de 4 hectares pour les bâtiments principaux.

Si l'on évalue, comme nous venons de le faire, la surface indispensable pour les bâtiments occupés par les officiers malades, par les officiers de santé et de l'intendance qui doivent

séjourner dans un grand hôpital; puis les locaux des cuisines et des magasins; les jardins, les plantations et les promenades, on arrivera à une surface de 12 hectares pour le terrain réservé à l'assiette d'un hôpital pouvant contenir 6,000 hommes.

Cette étendue de terrain paraît grande; mais il importe de donner à toutes les parties d'un tel établissement l'air et la lumière en abondance. C'est le seul moyen d'éviter les cours resserrées et les coins perdus qui sont des réceptacles humides ou obscurs et par conséquent malsains.

INCONVÉNIENTS QUE PRÉSENTE UN GRAND HÔPITAL. — AVANTAGES DE POSSÉDER PLUSIEURS HÔPITAUX DE MOYENNE GRANDEUR.

Outre la difficulté de trouver, au sein d'une ville, l'étendue de terrain suffisante pour établir un vaste hôpital, plusieurs motifs s'opposent à la réalisation du projet que nous venons d'esquisser. D'abord, son inutilité en temps de paix; ensuite la difficulté d'empêcher le désordre dans la concentration sur un seul point, de 6,000 malades ou blessés dont un grand nombre ne seront point alités.

On peut, en temps ordinaire, employer les bâtiments de l'hôpital au logement des troupes de la garnison. Mais ce serait exposer les locaux spéciaux à des dégradations qui les rendraient impropres à servir au moment du besoin.

En supposant qu'une partie de l'hôpital fut habitée par des malades, il serait imprudent d'y faire loger en même temps les hommes valides.

Il vaudrait mieux, dans ce cas, posséder plusieurs hôpitaux de moyenne grandeur, afin de pouvoir disposer librement, pour un usage quelconque, des bâtiments non occupés pour le service de santé.

Cette division permettrait de rapprocher les hôpitaux des points fortifiés où la défense aura le plus d'énergie. De sorte

que la distance à parcourir pour le transport des blessés serait la plus petite possible.

Enfin, on éviterait les inconvénients qui peuvent naître de l'indiscipline et de l'agglomération d'une foule d'hommes désœuvrés que la maladie n'empêchera pas toujours d'être mutins ou malfaisants.

Car, on ne peut être bien sévère dans un hôpital, et les moyens de coercition y sont naturellement limités.

Ces motifs nous décident à proposer deux hôpitaux destinés chacun à 3,000 hommes; et c'est en nous conformant à cette décision que nous allons continuer l'étude d'un projet d'hôpital militaire.

CHAPITRE II.

Projet d'hôpital militaire pour 3,000 hommes y compris les officiers.

DISPOSITIONS GÉNÉRALES.

Nous avons établi précédemment les conditions générales qui doivent présider à l'établissement des hôpitaux militaires. Nous allons maintenant pénétrer au cœur de la question, afin de l'envisager sous le point de vue de son application à un hôpital dans lequel nous chercherons à réaliser les avantages et les perfectionnements que la science et l'expérience ont fait connaître.

Consultons encore Laurillard-Fallot pour nous rendre compte des divers services pour lesquels les bâtiments doivent être préparés :

« Outre les salles destinées aux blessés et aux malades, un
« hôpital doit contenir une pharmacie, avec le magasin des
« préparations médicales et le logement des pharmaciens; un
« magasin aux linges et une dépense, attenants au logement
« de l'économe, composé au moins de deux pièces dont l'une
« sert de bureau; une salle de garde pour l'officier de santé
« de service, une salle destinée aux opérations chirurgicales
« graves; des salles de bains; des cuisines; le logement des

« infirmiers et du portier; un bureau et un corps de garde. Il
« faut des salles séparées pour les galeux et les vénériens,
« pour d'autres malades atteints de maladies contagieuses,
« pour les officiers; enfin, dans les dépendances de l'hôpital
« se trouvent les buanderies, l'amphithéâtre de dissection et
« une salle de désinfection des objets, puis une salle de morts
« où on les dépose en attendant l'inhumation. »

Nous nous baserons sur ces données en les modifiant en raison de la disposition générale que nous adopterons.

Une salle capable de contenir 100 lits sur quatre rangs parallèles aura, d'après nos calculs précédents, 800 mètres carrés, c'est-à-dire 16^m 00 de largeur et 50^m 00 de longueur.

Un rez-de-chaussée, deux étages et la mansarde pouvant contenir chacun 100 lits donneront un bloc destiné à 400 hommes.

Deux blocs semblables placés dans le prolongement l'un de l'autre et réunis par une partie de bâtiment de même hauteur contenant les locaux accessoires (*Pl. I*) constitueront un *hôpital partiel* suffisant pour 800 hommes.

En construisant quatre hôpitaux partiels disposés parallèlement et espacés de 20 mètres, on obtiendra un groupe de bâtiments qui pourront loger confortablement 3,200 hommes. (*Pl. II*.)

Ce groupe de bâtiments sera placé au milieu d'un carré de 300 mètres de côté, entouré d'un mur de clôture et renfermant tout le terrain nécessaire à l'érection des diverses constructions accessoires. (*Pl. II*.)

L'étendue des terrains compris dans le mur de clôture est de 9 hectares. On peut juger combien cette surface serait agrandie, au lieu d'adopter deux étages, on n'en avait admis qu'un seul.

DISPOSITION DES LOCAUX, ORIENTATION, DIMENSIONS DES SALLES
ET COMMUNICATIONS.

Nos calculs montrent que les quatre hôpitaux partiels pourront contenir 3,200 hommes. Toutefois, on en logera moins parce que toutes les salles ne pourront avoir les mêmes dimensions, et que, pour certaines maladies spéciales, il est prudent d'éviter de loger ensemble un grand nombre d'hommes.

Il faut aussi observer que sur 3,000 hommes on compte environ 125 officiers qui seront logés dans des bâtiments particuliers.

Par ce fait, il ne resterait à loger que 2,875 soldats malades sur 3,000 que nous considérons. Les bâtiments pouvant en contenir 3,200, c'est une différence de 325 places dont on pourra disposer pour les maladies exceptionnelles.

Comme les salles de 100 lits ne présentent aucune difficulté pour leur division, on pourra les partager dans certains cas selon les besoins du service.

On prendra sur ce point l'avis des médecins; car il serait difficile d'établir dans nos études, la proportion suivant laquelle les diverses catégories de malades se présenteront en temps de guerre.

On divise ordinairement, dans les hôpitaux militaires, les malades en cinq catégories : les fiévreux, les blessés, les vénériens, les ophtalmiques et les galeux. Mais chacune d'elles a des subdivisions qui présentent parfois des cas spéciaux qui doivent être traités dans des locaux particuliers.

Nous avons adopté pour type des salles, une place rectangulaire de 16^m 00 sur 50^m 00, parce que ces dimensions nous paraissent le mieux convenir pour la distribution et pour l'orientation des locaux. (*Pl. I*.)

Les chambres devant prendre le jour et la lumière des deux côtés opposés, on ne pourrait adopter la distribution que l'on

rencontre dans les couvents et les hôtels, c'est-à-dire une suite de chambres éclairées d'un côté seulement et communiquant de l'autre avec un long corridor. (Fig. 6.)

Afin de justifier la nécessité pour les grandes salles, de recevoir la lumière des deux côtés, nous rappellerons que le docteur Reid remarque que le mélange accidentel en petites proportions des gaz étrangers à l'air influe diversement suivant que le local est bien ou mal éclairé. Une proportion de 8 à 10 pour cent d'acide carbonique, par exemple, qui dans l'obscurité cause beaucoup d'oppression et de dangers, peut être supportable si l'on est exposé à une vive lumière; et sir Willy a constaté que dans une grande caserne à Saint-Petersbourg, les cas de maladie ont été pendant plusieurs années consécutives dans le rapport de 3 à 1 pour le côté peu éclairé comparé à celui qui jouissait d'une belle lumière. (RICHARD, *Aide-Mémoire des Ingénieurs*.)

On pourrait préférer des salles de 8 mètres de largeur pour deux rangs de lits. Mais, à cause de la condition de prendre l'air et la lumière des deux côtés, les bâtiments devraient s'étendre considérablement en longueur tout en conservant la largeur de 8 mètres. Il faudrait alors multiplier les blocs en les faisant plus petits, ce qui nuirait à la facilité du service.

Remarquons encore qu'en faisant les salles plus petites elles seraient placées à la suite l'une de l'autre, et qu'ainsi, les communications entre deux points extrêmes auraient lieu à travers les salles intermédiaires.

L'orientation devant être Nord-Sud, afin de profiter des vents d'Est et d'Ouest pour balayer les rues, on ne peut songer à former des retours aux ailes, ni à placer un avant-corps au milieu des bâtiments; car ces dispositions nuiraient à la circulation de l'air et laisseraient dans l'ombre quelques-uns des angles rentrants.

Afin de concilier l'orientation et les besoins du service, nous

conserverons la distribution adoptée dans les dispositions générales qui précèdent. Seulement, en conservant pour les grandes salles l'obligation de prendre le jour des deux côtés, nous croyons que l'on peut s'en dispenser pour les petites salles qui s'ouvriraient sur un corridor destiné à faciliter les communications. (Pl. I.)

C'est ainsi que dans la partie centrale de chaque hôpital partiel, outre les locaux nécessaires au service particulier de chaque bloc, se trouvera, à chaque étage, un certain nombre de petites salles de diverses grandeurs.

Par l'inspection des plans ci-joints, on trouvera que les dimensions des salles peuvent varier comme suit :

16 ^m 00	sur	50 ^m 00	pour	100 hommes.
16 ^m 00	—	25 ^m 00	—	50 id.
6 ^m 00	—	12 ^m 00	—	10 id.
6 ^m 00	—	8 ^m 00	—	6 id.
4 ^m 00	—	6 ^m 00	—	3 id.

Toutes ces salles contiennent 25 à 30 mètres cubes d'air par homme.

Il est inutile d'ajouter que les nombres d'hommes que nous indiquons peuvent être diminués, selon les vues du médecin ou le besoin du service.

Dans chaque hôpital partiel se trouve, au centre, un large vestibule en croix contenant deux grands escaliers et donnant accès aux diverses salles d'un même étage. (Pl. I.)

Le vestibule recevra le jour par les fenêtres des cages d'escalier, par les impostes de la porte d'entrée principale et par les impostes des portes des salles adjacentes.

A chaque aile existera un vestibule de dégagement contenant aussi un escalier et le local des latrines.

Cette disposition se répètera à chaque étage. Par ce moyen, les hommes logés dans chacune des ailes auront des communi-

cations particulières soit pour aller aux latrines, soit pour se rendre dans le préau, sans passer par le vestibule central réservé pour le service et les malades habitant des chambres réservées. Pour ces derniers et pour les employés, on établira à tous les étages une petite latrine sous les paliers des escaliers.

La division adoptée pour nos bâtiments est avantageuse, tant sous le rapport du service que sous le point de vue des dangers de l'incendie. D'abord chaque corps de bâtiment pourrait brûler sans nuire aux autres parties de l'établissement. Ensuite si quelque point des constructions venait à être incendié, la simplicité de la distribution des locaux et la facilité des communications permettraient d'évacuer promptement les salles menacées.

Dans le but de faciliter les communications entre les divers blocs et la chapelle on pourrait établir une galerie vitrée qui se trouve pointillée dans la planche II.

CHAPITRE III.

Organisation, bâtiments accessoires et détails de construction.

ORGANISATION.

Chaque hôpital partiel sera organisé comme un hôpital isolé, pour le service administratif et le service médical, ainsi que pour les entrées et les sorties des hommes.

Il s'y trouvera donc, dans les locaux situés au centre, des logements réservés pour un sous-directeur ou infirmier-major; pour les infirmiers (à raison d'un pour douze malades); pour les salles de garde du médecin et du pharmacien de service; des salles de bains et des lavoirs à chaque étage; une petite pharmacie, un magasin pour recevoir les armes et les effets des entrants; une lingerie et un magasin pour les vêtements de l'hôpital; une salle pour les opérations graves et une salle de visite à côté du bureau du sous-directeur.

L'ensemble des hôpitaux partiels sera dirigé par une administration supérieure.

A cet effet, on attachera à l'établissement un intendant, un directeur, un médecin principal et un pharmacien en chef, auxquels seront adjoints des officiers subalternes et des employés en nombre suffisant.

Des logements seront préparés pour ce personnel dans les bâtiments accessoires qui doivent être établis dans l'enceinte.

Outre ces logements, les bâtiments accessoires comprendront les cuisines, la dépense, les magasins divers, la pharmacie centrale, les salles pour les morts et l'amphithéâtre de dissection, les buanderies, la tisannerie, enfin tous les locaux accessoires qui, par économie ou par mesure hygiénique, seront placés en dehors des hôpitaux partiels et surveillés par l'administration centrale.

BÂTIMENTS ACCESSOIRES ET DÉPENDANCES.

Nous avons dit que le terrain occupé par l'hôpital et ses dépendances comprenait un carré de 300 mètres de côté, et que le groupe formé par les hôpitaux partiels était placé au milieu de l'enceinte. (Pl. II.)

Il reste donc, entre ces bâtiments et le mur de clôture, un espace très-étendu dont nous allons tirer parti pour les constructions accessoires.

Dans chaque angle du carré nous élevons un pavillon comprenant un rez-de-chaussée et un étage seulement, avec une cour intérieure. — Ces quatre pavillons contiendront tous les locaux et logements destinés au service général et à l'administration centrale.

Au nord et au milieu du mur de clôture se trouve la porte d'entrée principale, flanquée du corps de garde et du logement du portier.

A l'Est et à l'Ouest, deux préaux contenant des allées entourant deux longs promenoirs couverts.

Les bâtiments destinés au logement des officiers malades seront élevés dans les cours du Nord et du Sud, et orientés comme les hôpitaux partiels.

Une chapelle sera érigée dans le milieu de la cour du Sud.

Contre les murs de clôture seront construits des petits pavillons destinés à des latrines supplémentaires et à d'autres nécessités, telles que salles de police, etc.

Le plan d'ensemble représente à l'échelle de 0^m 000815 la disposition générale de toutes les constructions que nous venons d'indiquer.

Tous ces bâtiments seront pourvus de caves, de citernes, de puits, de pompes et de tous les accessoires nécessaires pour maintenir la propreté, l'ordre et la salubrité dans toutes les parties de l'établissement.

DÉTAILS DE CONSTRUCTION.

Le style à adopter pour les bâtiments de l'hôpital est le *roman*, dont les formes sévères satisfont au goût et à l'économie que l'on recherche dans les grandes constructions militaires. (Pl. III, Fig. 1.)

Les matériaux à employer sont :

Les moellons pour les fondations;

La pierre de taille pour les soubassements, les seuils des portes, les appuis des fenêtres, les culs-de-lampes ou modillons des arcades, les escaliers des caves, les couronnements des murs, etc.;

La brique pour tous les murs en élévation.

Les caves seront voûtées au moyen de petites voûtes en briques portées sur des poutrelles en fer.

On emploiera les poutrelles en fer pour les charpentes des planchers et des combles.

Les mansardes seront contre-gîtées et plafonnées en forme de berceau surbaissé.

Les toitures seront en zinc avec tasseaux.

Les châssis de croisée seront en fonte avec imposte mobile.

Les mansardes seront éclairées au moyen de châssis tabatières.

Les salles et les corridors seront planchés en chêne.

Les vestibules seront pavés en dalles.

Les planchers des ailes, dans les hôpitaux partiels, seront supportés par des colonnes en fonte superposées à chaque étage.

Ces colonnes, partant des fondations, recevront par assemblages les poutrelles principales en fer de chaque plancher, et se prolongeront dans les mansardes pour servir de poinçon à la charpente des combles.

Dans les façades, on formera des pilastres saillants destinés à renfermer les cheminées d'aérage des salles des divers étages.

Tous les bâtiments seront entourés de trottoirs pavés. On pavera également toutes les rues et les parties des cours destinées à la circulation des voitures.

Les promenoirs couverts seront formés d'une toiture en zinc portée par des colonnes en fonte. L'aire de ces promenoirs sera pavée comme les trottoirs.

Des allées sablées et des boulingrins occuperont les parties de l'enceinte qui resteront libres.

Les préaux seront séparés des cours par de petites grilles en fer reposant sur des soubassements en pierre de taille.

Les jardins dépendants des pavillons et les portions de cour réservées seront clôturés par des haies.

DEUXIÈME PARTIE.

CHAPITRE I^{er}.

Données théoriques et pratiques de chimie, de physique, de physiologie et d'hygiène à appliquer au chauffage et à l'aérage des hôpitaux militaires.

AIR ATMOSPHÉRIQUE.

Le milieu dans lequel nous vivons, l'air atmosphérique, doit, sous peine d'apporter des perturbations graves dans la santé de l'homme valide, posséder et conserver des qualités que les hygiénistes ont fait connaître.

La composition de l'air, son état hygrométrique, sa température ont, comme on le sait, une grande influence sur les organes sains; mais cette action est bien plus active encore sur les hommes malades, et c'est là le motif pour lequel le *chauffage* et la *ventilation* des hôpitaux sont les questions les plus importantes que les savants et les constructeurs soient appelés à résoudre.

L'air est formé en volume de 20,80 d'oxygène et de 72,20

d'azote. Il contient en outre, 0,0003 à 0,0009 d'acide carbonique et 0,006 à 0,009 de vapeur d'eau. (HERLANT.)

L'acide carbonique de l'air provient des combustions, de la décomposition des matières organiques et de la respiration des animaux.

Un litre d'air pèse 1,3 grammes (GAYOT). On conçoit que l'ensemble de l'atmosphère doive exercer à la surface du globe une pression considérable (indiquée par le baromètre) qui se modifie avec la température et l'état hygrométrique correspondant.

L'air est encore plus ou moins chargé de sporules, d'animalcules et de poussière appartenant aux trois règnes de la nature, dans laquelle on trouve même de la fécule. Enfin, l'air peut renfermer de l'ozone qui se rencontre en plus grande quantité aux étages supérieurs des bâtiments. (HERLANT.)

RESPIRATION.

D'après Dumas, un homme fait 16 à 17 expirations par minute; il transforme par heure en acide carbonique tout l'oxygène contenu dans 90 litres d'air, et le volume d'air qu'il expire par heure est de 333 litres contenant 0,04 d'acide carbonique.

La respiration de l'homme et des animaux, l'éclairage, le chauffage, la fermentation de toutes espèces de matières, enfin le dégagement des miasmes sont autant de causes d'altération de l'air.

Outre l'acide carbonique, l'oxyde de carbone et la vapeur d'eau qui se dégagent dans nos habitations par suite des causes signalées plus haut, l'homme et les animaux exhalent encore des gaz méphitiques difficilement appréciables à l'analyse chimique. C'est à ces gaz méphitiques que l'on doit l'altération de l'air dans les casernes, les hôpitaux et dans tous les locaux occupés par un grand nombre d'hommes ou d'animaux. Ces

gaz, lorsqu'ils sont respirés ont une action énervante qui, en exagérant la sensibilité du système nerveux, rend l'économie plus impressionnable à l'action de l'acide carbonique.

C'est pour cette raison que la quantité de ce dernier gaz ne doit jamais dépasser un demi pour cent.

D'après ces considérations, la dose d'air à fournir à chaque homme enfermé doit être de 6 à 10 mètres cubes par heure. Cette quantité doit s'élever à 18 mètres cubes par cheval. (PECLET.)

Il en résulte qu'un dortoir destiné à loger 50 hommes devrait avoir au moins 2,500 mètres cubes lorsqu'il est dépourvu d'appareil de ventilation ou de cheminées ouvertes. Cette énorme quantité de 2,500 mètres cubes d'air par 50 hommes, comme on le pense bien, est impossible à réaliser; jamais les casernes, les hôpitaux et les prisons ne seront assez vastes pour accorder 50 mètres cubes à chaque homme par nuit.

De là la nécessité de ventiler convenablement tous les locaux. (HERLANT.)

D'après des expériences faites à la Conciergerie par MM. Boussingault, Leblanc et Peclet, la dose d'air nécessaire à un *détenu* renfermé dans une cellule est de 10 mètres cubes par heure; la cellule contenait une cuvette mobile, cause exceptionnelle d'insalubrité.

Dans les hôpitaux, on a reconnu que les salles de chirurgie ne pouvaient être assainies et dépouillées de toute mauvaise odeur qu'avec une ventilation de 100 mètres cubes d'air par heure et par individu. (CLAUDEL.)

La respiration produit de la chaleur. Les chimistes expliquent cette chaleur en notant les quantités d'oxygène employées: 1° à former de l'acide carbonique et 2° à former de l'eau; le carbone et l'hydrogène étant fournis par l'économie animale. Mais cette analogie entre la respiration et la combustion n'est pas admise par tous les physiologistes.

TRANSPIRATION.

Il résulte d'expériences nombreuses qu'un homme, par sa transpiration cutanée et pulmonaire, produit en une heure 45 à 77 grammes de vapeur d'eau.

Un mètre cube d'air saturé à 15° contenant 13 grammes de vapeur, le volume d'air à moitié saturé que vicie un homme par heure par sa transpiration est :

$$\frac{45}{6,5} = 6^m 92 \text{ à } \frac{77}{6,5} = 11^m 85$$

Les limites précédentes 6^m 92 et 11^m 85 sont celles qui correspondent à une ventilation dans laquelle l'air pur arriverait par un grand nombre d'ouvertures pratiquées dans le sol et s'écoulerait par des orifices supérieurs. (CLAUDEL.)

ECLAIRAGE.

La flamme d'une bougie s'éteint lorsque l'air renferme 4 pour cent d'acide carbonique. En comparant la combustion à la respiration, M. Peclet évalue à 6 mètres cubes par heure la quantité d'air nécessaire à une bougie, et à 24 mètres cubes par lampe *gros bec*, pour que la combustion ait toujours lieu dans de bonnes conditions.

VENTILATION.

Il résulte des expériences de M. Peclet :

1° Qu'une ventilation de 6 mètres cubes par heure et par individu, est une limite au-dessous de laquelle il ne faut pas descendre, quand l'air de la ventilation est mêlé avec l'air de la pièce et qu'il n'existe aucune cause d'insalubrité;

2° Que, quand la ventilation a lieu de bas en haut, par tous les points du sol ou par des orifices très-nombreux et très-

rapprochés, une ventilation de 7 à 11 mètres cubes par heure et par personne, fournit à chacun de l'air paraissant suffisamment pur;

3° Que dans presque tous les cas, il y a des causes d'insalubrité pour lesquelles le chiffre de la ventilation doit être élevé à un point que l'expérience seule peut déterminer. (CLAUDEL.)

Dans les grandes salles de 100 lits que nous avons adoptées dans la 1^{re} partie de ce travail, le volume d'air est :

$$16 \times 50 \times 5 = 4000 \text{ mètres cubes.}$$

En supposant que la ventilation renouvelle l'air à raison de 10 mètres cubes par heure et par homme, il faudra qu'il entre et qu'il sorte une quantité de 1000 mètres cubes par heure; ce qui fait qu'en 4 heures tout l'air de la salle serait renouvelé.

Mais comme l'air frais se mélange avec l'ancien, il faut que la ventilation soit constante et qu'elle puisse varier avec les causes d'insalubrité qui peuvent accidentellement se trouver dans les salles.

Cependant, le chiffre de 10 mètres cubes par heure et par homme paraît être une moyenne qui s'accorde avec les faits d'expérience signalés par M. Peclet.

Nous admettons ce chiffre, qui nous semble suffire quand l'aérage a lieu d'une façon continue, et quand les salles sont assez grandes pour contenir l'air nécessaire à la respiration pendant quelques heures.

Pour une quantité de 1000 mètres cubes par heure, le renouvellement de l'air devrait se faire avec une vitesse que nous allons calculer.

Il entrera dans la salle un volume de

$$\frac{1,000}{3,600} = 0,278 \text{ mètre cube par seconde.}$$

S'il y a 24 bouches d'aérage, chacune devra fournir

$$\frac{278}{24} = 11,583 \text{ décimètres cubes par seconde.}$$

En donnant aux bouches d'aérage une section d'un décimètre carré, la vitesse sera égale à la hauteur d'un prisme qui aurait pour volume 0^m3 011583 et pour base 0^m1 01; d'où la vitesse sera

$$\frac{11,583}{10,000} = 1^{\text{m}} 458 \text{ par seconde.}$$

Cette vitesse est à peu près celle du vent à peine sensible. A la vérité, elle est subordonnée à la différence des températures intérieure et extérieure qui varient avec le chauffage d'une part et avec l'état de l'atmosphère d'autre part.

C'est pourquoi il est avantageux de combiner la ventilation avec le chauffage des salles.

DU CHAUFFAGE DES SALLES ET DE L'INFLUENCE DES CHANGEMENTS DE TEMPÉRATURE SUR L'HOMME.

Nous devons considérer le chauffage des salles dans son but et dans les moyens employés pour la production de la chaleur.

Le but qu'on se propose en chauffant les salles, consiste à procurer à l'air qui s'y trouve et à celui qui y arrive la température nécessaire pour que l'homme n'y éprouve ni la sensation du *chaud* ni les effets du *froid*.

La température du corps humain est de 37 à 38 degrés et ne peut varier que de quelques degrés en plus ou en moins.

« A l'exception de quelques pays équatoriaux et encore pendant la saison chaude et au milieu du jour, l'atmosphère a toujours une température qui est inférieure à celle de l'homme; le degré varie selon les climats et les saisons;

« conséquemment l'atmosphère nous soutire sans cesse du calorique.

« Si nous conservons néanmoins notre température indépendante, c'est que notre puissance vitale renouvelle notre chaleur à mesure qu'elle nous est enlevée. Nous sommes encore organisés de manière à avoir besoin de cette soustraction continue de chaleur. Si elle cessait tout à coup d'avoir lieu, ou diminuait beaucoup, notre température s'élèverait graduellement, et quand elle serait haussée de 7° ou 8°, on périrait.

« D'autre part, si cette soustraction devenait extrême, et telle que la vie ne puisse pas renouveler le calorique aussi promptement qu'il est enlevé, notre température baisserait, nos humeurs se congèleraient, et quand la température serait baissée à 26° on périrait encore.

« Entre ces deux extrêmes il y a de nombreux intermédiaires signalés par les sensations de *chaud* et de *froid*. » (ADELON.)

Cette citation fait voir toute l'importance qu'on doit apporter au chauffage d'un hôpital, et la nécessité de maintenir l'air intérieur à une température moyenne capable de conserver au corps humain sa chaleur normale.

La température de l'air au milieu duquel on vit a, comme on le sait, une grande influence sur la transpiration cutanée qui s'arrête par le froid et qui se change en sueur par l'excès de chaleur.

« Que la perspiration cutanée soit contrariée, souvent alors la nature transporte sur d'autres systèmes la matière dont cette sécrétion devait débarrasser le corps; et diverses maladies éclatent, ou des rhumatismes, ou des hydrosies, ou des dysenteries, des catarrhes, selon que ce sont les systèmes musculaires séreux, le canal intestinal, les membranes muqueuses, qui deviennent le point de la fluxion. » (ADELON.)

D'autre part, on n'ignore pas que si les salles sont trop chauffées, la transpiration trop abondante et continue affaiblit les malades; ensuite l'air en sera d'autant plus vicié, ce qui exigera une ventilation plus rapide pour le ramener à son état normal.

Le dispositif du chauffage doit donc être combiné avec la ventilation de façon à permettre de varier la quantité de chaleur à fournir en raison du renouvellement de l'air selon la saison et les influences atmosphériques.

Car l'air, selon qu'il est sec ou humide, froid ou chaud, exerce avec plus ou moins d'énergie son action physique sur notre corps. — Il faut donc que l'officier de santé, chargé du service dans un hôpital, trouve dans les systèmes de chauffage et d'aérage les moyens propres à placer les malades dans un milieu qui soit en rapport avec les conditions hygiéniques qu'il croit convenables.

CHAPITRE II.

Recherches sur les systèmes de chauffage et de ventilation en usage.

CONSIDÉRATIONS GÉNÉRALES.

Connaissant le but du chauffage et de l'aérage, nous pouvons étudier les moyens que l'industrie emploie pour l'atteindre et constater les avantages ainsi que les inconvénients de chaque système.

Dans les établissements où l'on doit chauffer et ventiler de vastes salles destinées à contenir un grand nombre de personnes, on cherche à combiner l'aérage avec le chauffage en utilisant la chaleur d'un *calorifère* pour déterminer les courants d'air qui constituent la ventilation.

Car il ne suffit pas de chauffer l'air d'une salle; il faut que cet air soit renouvelé au fur et à mesure qu'il est corrompu par la respiration et par les diverses causes qui en modifient la composition.

Pour le renouveler, il faut le puiser à une source pure, c'est-à-dire dans la masse atmosphérique extérieure. Mais comme il arrive fréquemment que l'air du dehors possède une température plus basse que celle de l'intérieur, et qu'il y aurait de l'inconvénient à le laisser pénétrer dans cet état, on doit

chauffer l'air d'arrivée, et l'appareil de calorification doit être préparé pour cette fin.

On emploie diverses espèces de foyers ou de poêles pour produire de la chaleur dans les salles. Souvent le calorifère est placé en dehors du milieu à chauffer. L'air puisé à l'extérieur arrive d'abord au foyer; puis, après s'être échauffé, il pénètre dans les salles où il est appelé au moyen de la ventilation produite, soit en profitant de la cheminée du calorifère, soit à l'aide d'une cheminée d'appel ayant son propre foyer, soit enfin par l'action d'un ventilateur mû par une force mécanique.

D'autres fois le calorifère transmet sa chaleur à une certaine quantité d'eau qui, en circulant à l'intérieur d'une suite de tuyaux placés dans les salles, répand son calorique par rayonnement sur tout son parcours.

La circulation de la vapeur d'eau sert aussi au chauffage des établissements. En circulant dans des tuyaux, la vapeur se condense, son calorique se communique aux tuyaux qui, à leur tour, chauffent l'air ambiant.

Enfin, l'eau et la vapeur sont parfois employées en même temps pour le chauffage des salles. L'eau étant placée dans des réservoirs qui communiquent avec un générateur, la vapeur vient se condenser dans les réservoirs et ceux-ci rendent à l'air le calorique qu'ils ont reçu par la condensation.

ÉNUMÉRATION DES SYSTÈMES DE CHAUFFAGE USITÉS.

Les appareils qui servent au chauffage des salles, peuvent se distinguer comme suit :

1° Les foyers ouverts dans lesquels le chauffage de l'air a lieu par le rayonnement du combustible et de la flamme;

2° Les poêles fermés qui chauffent l'air par le rayonnement du calorique qui s'échappe des parois du foyer et des tuyaux de conduite de la fumée;

3° Les poêles ouverts dans lesquels on réunit les deux systèmes précédents;

4° Les calorifères à air chaud qui consistent en un foyer dans lequel des tuyaux amènent l'air de l'extérieur pour le chauffer et le conduire ensuite dans les salles;

5° Les calorifères à eau chaude dans lesquels un foyer situé en bas chauffe une chaudière mise en communication avec une seconde chaudière placée à l'étage supérieur.

Les deux chaudières sont en outre reliées par des tuyaux de circulation placés dans les salles.

Par la chaleur du foyer, l'eau de la chaudière inférieure tend à s'élever dans la chaudière supérieure; l'eau froide de celle-ci s'échauffe alors, et met en mouvement l'eau des tuyaux de circulation qui vient remplacer l'eau chaude que la chaudière inférieure perd à chaque instant. Ce mouvement circulaire de l'eau chaude répand la chaleur produite par le foyer;

6° Les calorifères à vapeur, qui se composent d'un générateur produisant la vapeur d'eau à une tension plus ou moins forte, pour la faire passer dans des tuyaux placés dans les salles. La vapeur sert ainsi de véhicule au calorique produit par le foyer du générateur;

7° Les calorifères à vapeur et à eau chaude qui sont la combinaison des deux derniers systèmes. L'eau des réservoirs placés dans les salles accumule le calorique qui est transporté par la vapeur s'échappant du générateur.

Dans les quatre derniers systèmes, les tuyaux de circulation, soit de l'air, de l'eau ou de la vapeur, sont parfois placés dans des augets, sous les planchers, dans lesquels s'ouvrent des bouches de chaleur.

MOYENS DE VENTILATION.

Lorsqu'on chauffe une chambre par un foyer ouvert, un poêle ou un calorifère situés dans la place à chauffer, la com-

bustion a lieu aux dépens de l'air intérieur; de sorte que s'il se trouve des ouvertures qui permettent à l'air extérieur de pénétrer dans la place, le chauffage et la ventilation s'opèrent en même temps.

D'ordinaire, pour les habitations, les fissures des portes et des fenêtres suffisent au renouvellement de l'air dans les chambres.

Mais dans les grands édifices, les amphithéâtres, les églises, les ateliers, etc., les joints des portes et des fenêtres ne peuvent plus suffire, parceque le volume d'air croît comme le produit des trois dimensions du local, et que le nombre d'habitants peut être proportionné à la surface du plancher; tandis que le nombre des fenêtres reste proportionnel à la longueur des façades, et que le nombre des portes demeure à peu près le même, quelque soit la grandeur de la salle.

On pourrait, il est vrai, multiplier les portes et les fenêtres afin de donner plus facilement accès à l'air extérieur. Mais il est des convenances de construction auxquelles on ne peut se soustraire. En outre, les portes et les fenêtres sont, par leur nature, des causes de refroidissement pour l'air intérieur. C'est pourquoi il est plus rationnel de provoquer le renouvellement de l'air par un système de ventilation d'une activité suffisante pour conserver dans les salles les conditions hygiéniques indispensables.

Quand la température extérieure diffère *très-peu* de celle de l'intérieur, le renouvellement de l'air peut se faire en ouvrant les portes et les fenêtres. Mais ce moyen naturel de ventilation ne peut être employé qu'exceptionnellement parce que, dans nos climats, la différence des saisons et les variations atmosphériques sont trop considérables, et qu'il y aurait danger pour les habitants d'une salle à y laisser pénétrer une grande quantité d'air froid ou humide, alors que la température doit être maintenue dans les limites de 15° à 20°.

L'hygiène exige que le renouvellement de l'air s'opère d'une façon continue et insensible, non par une grande ouverture, mais par le plus grand nombre possible de *bouches* d'une grandeur telle que la vitesse du courant d'air n'ait rien de pénible pour les malades. Cette vitesse ne peut dépasser 1^m 25 par seconde, car si à la vitesse de 1^m 00 le vent est à peine sensible, à la vitesse de 2^m 00 on a l'effet d'une brise légère.

Dans le chapitre précédent, nous avons trouvé, par nos calculs, qu'une vitesse de 1^m 158 par seconde suffit pour renouveler en quatre heures les 4000 mètres cubes d'air d'une salle, en ouvrant 24 bouches, ayant chacune un décimètre carré, pour laisser entrer l'air extérieur.

Une telle ventilation pourrait suffire quand l'air extérieur n'a pas une température très-basse; mais, pendant les grands froids, il faut nécessairement que l'air nouveau soit réchauffé avant de pénétrer dans les salles. Il faut donc que les tuyaux de prise d'air aboutissent au calorifère, et celui-ci doit être établi de façon à porter rapidement à une température convenable, l'air arrivant du dehors.

Mais ne perdons pas de vue qu'il ne suffit pas, pour ventiler une salle, de prendre de l'air à l'extérieur et de le chauffer; il faut en même temps que l'air vicié de l'intérieur de la salle soit expulsé avec une vitesse suffisante pour que sa présence ne soit pas un obstacle à l'entrée de l'air frais.

Car celui-ci ne peut entrer qu'à la condition que la pression extérieure soit plus grande que la pression intérieure. Il est vrai que les hauteurs barométriques mesurant ces pressions ne doivent pas différer beaucoup; mais si petite que soit leur différence, elle rompra l'équilibre et le courant s'établira.

Si l'air intérieur ne pouvait s'échapper proportionnellement à l'arrivée de l'air frais, la différence des températures ne suffirait pas pour rendre durable le courant d'introduction.

attendu que l'air chaud de la salle, après un certain temps, s'opposerait par son élasticité à l'entrée du nouvel air.

Il y aurait équilibre malgré la différence des températures, parce que l'air chaud renfermé résisterait par sa tension à la pression de l'air extérieur.

Il est donc évident que la ventilation comprend l'évacuation de l'air intérieur en même temps que l'introduction de l'air pris au dehors, et que les deux courants qui en résultent ont des vitesses proportionnelles à la température ou en raison inverse de la densité du fluide.

Ainsi, l'air chaud de la salle aura moins de densité et devra s'écouler avec une vitesse plus grande que la vitesse de l'air froid extérieur, ayant une plus grande densité à son arrivée.

L'urgence d'un moyen d'évacuation pour l'air qui a séjourné dans les salles étant incontestable, il s'agit d'appliquer à l'hôpital que nous avons étudié, le système le plus avantageux et le plus économique.

On peut employer pour l'aérage :

- 1° Les ventilateurs;
- 2° La cheminée.

LES VENTILATEURS, LEUR EFFET UTILE.

On emploie diverses espèces de machines pour mettre l'air en mouvement, le refouler, l'aspirer ou l'insuffler.

Tout le monde connaît le soufflet de forge. On connaît aussi le ventilateur désigné sous le nom de *machine soufflante*, et qui consiste en une espèce de pompe très-grande aspirant l'air par des soupapes et le refoulant par un mouvement de va et vient communiqué au piston par un moteur hydraulique ou à vapeur.

Le soufflet et la machine soufflante sont abandonnés depuis l'introduction dans l'industrie du *ventilateur à force centrifuge*.

Cette dernière machine étant surtout avantageuse lorsqu'il

s'agit de fournir un grand volume d'air à une faible tension, c'est elle que l'on préfère généralement pour la ventilation.

Les ventilateurs ordinaires sont formés d'une caisse ou tambour cylindrique dans lequel tournent quatre ou six ailes planes ou légèrement convexes. Le mouvement de rotation des ailes se produit avec une vitesse qui peut varier de 400 à 1500 tours par minute.

Le ventilateur a deux ouvertures d'aspiration, l'une à droite, l'autre à gauche, au centre des deux bases du cylindre. Une troisième ouverture, située à la surface cylindrique sert à la projection de l'air aspiré. A cette troisième ouverture s'adapte le tuyau d'émission dont la paroi inférieure est tangente à la surface cylindrique du tambour.

Si le ventilateur doit refouler de l'air frais dans un milieu non aéré, la machine est placée au dehors, et le tuyau d'émission est prolongé jusqu'au point où l'air doit être projeté.

Si, au contraire, le ventilateur doit extraire l'air vicié d'une salle, les ouvertures d'aspiration sont pourvues chacune d'un entonnoir terminé par un tuyau bifurqué qu'on prolonge jusque dans la place à ventiler. Le tuyau d'émission est dirigé vers le dehors.

Nommant V' le volume d'air qui doit être extrait des salles des quatre hôpitaux partiels dans une seconde, V le volume qu'aurait à 0° le même poids d'air;

α le coefficient de dilatation de l'air;

t le nombre de degrés indiquant la température de la masse d'air V' .

On aura pour V , d'après Ganot,

$$V = \frac{V'}{1 + \alpha t}$$

Faisant $t = 15^\circ$, $\alpha = 0,00366$ et $V' = 8^{m3} 896$, il viendra

$$V = 8^{m3} 433$$

Multipliant ce volume par $1^{\text{e}} 3$ poids d'un mètre cube d'air à 0° , on aura $10^{\text{e}} 963$ pour le poids des $8^{\text{m} 3} 896$ d'air à 15° qu'il s'agit de faire sortir des bâtiments de l'hôpital.

Nous avons évalué précédemment à $1^{\text{e}} 158$ par seconde la vitesse d'écoulement de l'air de la ventilation.

Le poids de l'air extrait par seconde multiplié par la vitesse d'écoulement nous donnera une quantité de travail égale à $12^{\text{e}} = 693$.

Cette quantité de travail doit être multipliée par 4 pour tenir compte de la perte due au frottement dans les tuyaux et à l'influence des coudes. On aura ainsi $50^{\text{e}} = 780$.

Considérant que d'après les expériences rapportées par Claudel, le rapport entre l'effet utile et la force motrice consommée par le ventilateur ne dépasse pas 0,16 on aura en nommant T le travail moteur

$$\frac{50^{\text{e}} = 780}{T} = 0,16$$

D'où

$$T = 317^{\text{e}} = 37$$

Eufin, on sait qu'une machine à vapeur ne donne en réalité que 0,75 du travail de la vapeur produite.

Soit T' ce dernier travail; il viendra

$$\frac{317^{\text{e}} = 37}{T'} = 0,75$$

et l'on aura

$$T' = 423^{\text{e}} = 16$$

Divisant cette quantité de travail par la valeur d'un cheval-vapeur, nous aurons pour la force motrice nécessaire à l'aérage des salles par des ventilateurs, 5,64, soit 6 chevaux-vapeur.

L'établissement d'un système d'aérage par la vapeur comprendrait quatre ventilateurs (dont un par hôpital partiel) qui seraient mûs au moyen d'un arbre de couche partant de la machine.

Chaque ventilateur devant aspirer $2^{\text{m} 3} 224$ d'air par 1^{e} , en faisant 10 tours par seconde, le volume d'une révolution des ailes serait $0^{\text{m} 3} 222400$.

La vitesse de 600 tours par minute convient lorsque l'on veut éviter le roulement des ventilateurs.

La consommation de houille nécessaire à la machine peut être calculé à raison de $3^{\text{e}} 0$ par force de cheval et par heure. C'est donc $432^{\text{e}} 0$ par 24 heures de ventilation. (Voir l'appendice.)

LA CHEMINÉE, SON TIRAGE, SA HAUTEUR.

La cheminée est, en général, un tuyau dans lequel s'établit un courant de bas en haut par l'effet d'une différence de densité entre les matières gazeuses qui se trouvent à l'extérieur et à l'intérieur de la cheminée. Cette différence de densité s'obtient par la différence des températures.

Ainsi, en chauffant l'air contenu dans une cheminée ouverte aux deux bouts, le poids de la colonne gazeuse qui se trouve à l'intérieur étant moindre que le poids d'une égale colonne d'air extérieur, l'équilibre est rompu et le courant ascendant qui s'ensuit se continue jusqu'à ce que, la source de chaleur cessant de dilater l'air qui s'introduit dans la cheminée, l'équilibre se rétablisse par l'égalité des densités.

Le tirage peut également se produire dans une cheminée sans le secours de la chaleur. Par exemple, si la tension manométrique du milieu où plonge l'ouverture inférieure de la cheminée est plus grande que la pesanteur de l'air libre dans le tuyau, le courant ascendant s'établira et durera jusqu'à ce que le manomètre corresponde à la hauteur barométrique.

On peut aussi produire le *tirage* dans une cheminée en y faisant déboucher le conduit d'un ventilateur, ou bien en y faisant arriver le tuyau de décharge de la vapeur d'une machine.

Ce dernier moyen s'emploie pour activer le tirage de la cheminée des locomotives.

En outre, lorsque l'air contient des gaz plus légers que lui, le mélange s'établit par couches de telle sorte que les plus légères restent au-dessus des couches les plus lourdes, et si la masse gazeuse est mise en communication avec une cheminée non chauffée et s'ouvrant dans l'atmosphère, il s'établit un courant ascendant formé par l'air des couches légères qui tendra à s'élever comme les corps flottants dans un fluide. Mais il pourra en même temps s'établir un courant descendant formé par l'air atmosphérique venant combler le vide dans la masse gazeuse et rétablir l'équilibre entre les densités.

En général, on peut affirmer qu'on produira un courant toutes les fois que par un moyen quelconque, on fera naître une différence de densité ou de tension entre deux masses d'air que l'on mettra en communication entre elles.

On nomme *cheminée d'appel* une cheminée destinée à appeler l'air vicié des espaces à ventiler pour le conduire, par un courant ascensionnel, dans les couches atmosphériques supérieures.

Le courant peut être occasionné par divers moyens, ainsi que nous venons de le dire; mais c'est ordinairement par la chaleur que l'on produit le tirage des cheminées d'appel.

A cet effet, on profite souvent des produits de la combustion du foyer d'un générateur à vapeur ou d'un calorifère. Mais comme il est avantageux de pouvoir produire la ventilation en tous temps, on pourvoit la cheminée d'appel d'un foyer spécial destiné à fournir la quantité de chaleur nécessaire pour entre-

tenir le tirage d'une façon permanente, avec la vitesse exigée par les besoins de la ventilation.

On peut avoir une cheminée dans chaque place ou local à ventiler. Parfois on n'établit qu'une seule cheminée d'appel pour ventiler tous les locaux d'un vaste établissement, tel que prison, atelier, caserne, etc. Dans ce cas, un système de tuyaux ramifiés vont aspirer l'air des locaux pour l'amener dans la cheminée d'appel.

Examinons les conditions que devrait remplir une cheminée d'appel destinée à ventiler un hôpital partiel.

Soit H la hauteur de la cheminée;

H' et H'' les hauteurs des colonnes d'air dont les températures t' et t sont ramenées à 0°;

v la vitesse d'arrivée de l'air à 15° venant des salles;

v' la vitesse de sortie de l'air chauffé dans la cheminée d'appel;

t la température de l'air extérieur;

t' la température de l'air dans la cheminée d'appel;

α le coefficient de dilatation de l'air.

La colonne d'air chaud, dans la cheminée, est pressée de haut en bas par la pression de l'atmosphère comptée jusqu'au sommet de la cheminée; de bas en haut par la même pression augmentée d'une colonne d'air froid dont la hauteur égale H .

De sorte que le *tirage* de la cheminée est déterminé par la différence de poids entre deux colonnes de même hauteur, l'une d'air chaud et l'autre d'air froid.

Si, conservant la même base, nous ramenons à 0° la température des deux colonnes d'air, elles auront la même densité, mais les hauteurs H' et H'' seront inversement proportionnelles aux températures primitives t et t' . La différence des hauteurs obtenues sera la hauteur h en vertu de laquelle on calculera la vitesse du *tirage* de la cheminée d'appel.

On a d'abord :

$$H' = \frac{H}{1 + \alpha t}$$

$$H'' = \frac{H}{1 + \alpha t'}$$

Dont la différence sera :

$$h = H' - H'' = \frac{H \alpha (t' - t)}{1 + \alpha t'}$$

en négligeant αt et $\alpha^2 t t'$ qui sont très petits.

Nous aurons donc pour la vitesse de sortie de l'air chaud de la cheminée :

$$v' = \sqrt{2 g h} = \sqrt{\frac{2 g H \alpha (t' - t)}{1 + \alpha t'}} \quad (4)$$

Cette formule servira à calculer H quand la vitesse d'évacuation de l'air chaud sera connue.

On peut obtenir immédiatement la valeur de v' en fonctions de v , t et t' .

En effet, si l'écoulement de deux masses d'air a lieu par des orifices de même section, il faut, pour que les quantités écoulées dans le même temps soient égales en poids, que les vitesses soient en raison inverse des densités, d et d' , c'est-à-dire proportionnelles aux températures. (*)

On aura :

$$\frac{v'}{v} = \frac{d}{d'} = \frac{t'}{t}$$

(*) Le mélange des gaz produits par la combustion du foyer d'appel (azote et acide carbonique) possède une densité qui diffère très-peu de la densité de l'air; de sorte qu'on peut, dans la pratique, considérer ces densités comme étant égales.

D'où

$$v' = \frac{v t'}{t} \quad (2)$$

Supposons que la température moyenne de l'intérieur de la cheminée d'appel soit $t' = 300^\circ$; que celle de l'air extérieur soit $t = 15^\circ$; et que le coefficient de dilatation $\alpha = 0,00366$; nous aurons successivement :

$$v' = \frac{1^m 458 \times 300}{15} = 23^m 16$$

Remplaçant v' par sa valeur dans (4)

$$H = \frac{v'^2 (1 + \alpha t')}{2 g \alpha (t' - t)}$$

$$H = \frac{(23,16)^2 (1 + 0,00366 \times 300)}{2 \times 9,81 \times 0,00366 (300 - 15)}$$

$$H = 33^m 87$$

Si l'on donne à la cheminée d'appel une section équivalente à la somme des bouches d'aérage des salles, cette section sera :

$$\pi R^2 = 8 \times 0^m 24 = 1^m 92$$

dont le rayon est :

$$R = \sqrt{\frac{1,92}{3,14}} = 0^m 782$$

Les résultats précédents prouvent que pour ventiler un hôpital partiel au moyen d'une cheminée d'appel, cette che-

minée devrait avoir 33^m 87 de hauteur et un diamètre intérieur de 1^m 564.

En consultant Claudel, on voit que pour la prison de Mazas, dont la ventilation a lieu par une cheminée d'appel évacuant 30,000 mètres cubes d'air par heure, la consommation de houille est de 25^k par heure.

Pour notre hôpital partiel, la ventilation doit être de 8,000 mètres cubes par heure. Par analogie, nous aurons pour la consommation de charbon nécessaire :

$$30,000 : 25 = 8,000 : x$$

$$x = \frac{25 \times 8}{30} = 6^k 66$$

Ce qui donne pour 24 heures 160^k environ de combustible pour ventiler un hôpital à l'aide d'une cheminée d'appel.

Pour les quatre bâtiments il faudrait donc 640 kilogrammes de houille.

L'aérage par les ventilateurs n'exige que 432 kilogrammes.

VENTILATION PAR LA CHEMINÉE DU CALORIFÈRE.

Pour l'application dont il s'agit dans la ventilation des salles d'un hôpital, le moyen qui nous paraît être le plus simple et le plus naturel consiste à profiter de la cheminée du calorifère pour produire l'évacuation de l'air vicié. A cet effet, on introduit dans la cheminée un tuyau coudé, dont la partie horizontale vient s'ouvrir, sous forme d'entonnoir, dans le plafond de la salle à ventiler.

L'air vicié qui avoisine l'entonnoir est forcé d'y entrer par suite de la dilatation de l'air dans le tuyau d'appel.

Nous reviendrons sur ce moyen de ventilation en décrivant le système d'aérage à adopter.

COMBINAISON DU CHAUFFAGE ET DE LA VENTILATION.

Cette combinaison exige que le calorifère remplisse les trois fonctions suivantes :

- 1^o Chauffer l'air arrivant du dehors;
- 2^o Chauffer le bâtiment et entretenir dans les locaux une température moyenne constante;
- 3^o Permettre l'évacuation de l'air vicié par la cheminée du foyer au moyen de tuyaux d'appel.

On pourrait objecter que, pendant l'été, le calorifère ne fonctionnant point, le tirage de sa cheminée pourrait être nul.

Mais il existe plusieurs moyens de remédier à cet inconvénient. D'abord, il faut observer que dans les lieux situés dans la zone tempérée, il n'y a guère que trois mois pendant lesquels le chauffage des salles ne soit pas nécessaire. Et encore voit-on souvent pendant les mois de juin, juillet et août, des journées et des nuits où la température baisse assez pour désirer du feu dans les appartements.

Dans les salles d'un hôpital, les poêles ou les calorifères doivent rester en place d'une façon permanente, parceque le chauffage doit y être réglé d'après l'état de l'atmosphère, et non comme dans les corps-de-garde, selon les saisons indiquées par le calendrier.

En outre, on doit adopter un système de calorifère qui permette de varier la chaleur produite en raison des changements atmosphériques. Ce résultat peut s'obtenir en faisant varier la surface de la grille du foyer, afin de diminuer ou d'augmenter la consommation du combustible.

Enfin, pendant les temps chauds, on se dispensera de chauffer le calorifère en substituant à son foyer une lampe ou une veilleuse brûlant de l'huile minérale dont la chaleur suffira pour dilater la colonne d'air contenue dans la cheminée.

Pour compléter ce système, il faut que les conduits servant

de prise d'air au dehors, outre leur communication avec le calorifère, possèdent une deuxième bouche s'ouvrant dans la salle et servant à l'introduction de l'air frais quand on ferme la bouche du calorifère.

CHAPITRE III.

Discussion sur les calorifères en usage.

CONDITIONS AUXQUELLES L'APPAREIL DE CHAUFFAGE DOIT SATISFAIRE.

Dans le chapitre précédent, nous avons fait l'énumération des divers systèmes de chauffage usités. Il nous reste encore à les discuter avant de nous fixer sur le choix que nous pourrions faire de l'un d'eux pour l'appliquer à notre projet d'hôpital.

Disons, d'abord, que le mode de distribution de nos locaux fait que toutes les grandes salles se trouvent superposées dans les deux ailes des hôpitaux partiels; tandis que les petites chambres sont distribuées dans la partie centrale de chaque bâtiment.

Nous croyons que s'il est avantageux que les grandes salles soient chauffées uniformément par un même système de calorifère, il n'en est pas de même pour les locaux plus petits destinés à divers services.

Nous considérerons donc les petites salles comme se trouvant en dehors du système de chauffage à appliquer, en laissant à l'administration le soin de choisir parmi les poêles en usage ceux qui conviennent pour les chambres spéciales.

D'ailleurs, toutes ces chambres pourront profiter des cheminées que nous avons prévues et qui se trouveront à chaque étage dans les pilastres des murs de façades. Ensuite, rien ne sera plus aisé que de donner plus de développement au système que nous adopterons pour le chauffage et l'aérage des grandes salles qui constituent la partie essentielle de chaque hôpital partiel.

Voici, selon nous, les conditions auxquelles l'appareil de chauffage doit satisfaire :

- 1° Consommer un minimum de combustible;
- 2° Coûter le moins possible pour son établissement;
- 3° Exiger peu de frais d'entretien et de réparation;
- 4° Ne présenter ni danger ni inconvénient;
- 5° Permettre de régler à volonté la production de la chaleur;
- 6° Se prêter à une bonne ventilation;
- 7° Distribuer la chaleur également à toutes les salles et dans toutes les parties de chacune d'elles.

L'expérience a prouvé qu'aucun des systèmes connus ne satisfait complètement à ce programme. C'est ce que nous allons montrer par l'examen de ceux que nous avons énumérés.

FOYERS OUVERTS.

Ils sont sains, agréables et faciles à établir.

Ils concourent à la ventilation des locaux où ils se trouvent; mais ils consomment beaucoup de combustible, dont 13 pour cent seulement pour la chaleur utilisée. Ils chauffent trop dans leur voisinage et pas assez dans les parties éloignées du foyer. Leur chaleur n'est pas uniforme et ils ont en outre l'inconvénient de produire une grande quantité de poussière.

POÊLES FERMÉS.

Les poêles fermés, lorsqu'ils sont bien construits, sont propres, commodes et très-économiques.

Ils sont ordinairement pourvus de tuyaux en tôle qui conduisent les gaz de la combustion dans une cheminée en maçonnerie. La surface chauffée est alors considérable, ce qui permet d'utiliser 0,80 pour cent de la chaleur produite par le combustible.

Mais leur foyer en fonte, chauffé au rouge, aisse échapper de l'acide carbonique et de l'oxide de carbone qui vicient l'air ambiant. Quand les tuyaux métalliques sont fortement chauffés, les matières organiques en suspension dans l'air viennent s'y brûler, ce qui occasionne une mauvaise odeur. Du reste ces poêles peuvent se combiner avec un bon système de ventilation.

Dans ce but, on entoure le foyer d'une enveloppe en tôle ou en fonte laissant entre elle et le poêle un espace plus ou moins grand que vient remplir l'air froid puisé au dehors. Cet air se chauffe et se répand ensuite dans la salle.

Pour l'évacuation de l'air vicié, on ouvre dans la cheminée en maçonnerie l'ouverture destinée au tuyau d'appel dont nous avons parlé au chapitre précédent.

SYSTÈME PECCLET.

M. E. Pecclet est l'auteur d'une instruction sur le chauffage et la ventilation des écoles primaires et des salles d'asile, dans laquelle la question qui nous occupe est résolue de la façon la plus avantageuse.

Aussi, nous nous rallions à cette instruction pour en appliquer les idées autant que possible à notre projet d'hôpital.

Le poêle-calorifère proposé par M. Pecclet présente plusieurs avantages :

1° Le foyer est revêtu à l'intérieur d'une chemise en briques réfractaires, qui empêche le poêle de rougir et supprime la production de l'acide carbonique et de l'oxide de carbone;

2° L'air nécessaire à l'aérage de la salle arrive du dehors par un orifice placé sous le plancher et s'introduit dans l'espace qui sépare le poêle de son enveloppe;

3° La partie supérieure de l'enveloppe est percée d'un certain nombre de trous destinés à laisser pénétrer l'air chaud dans la salle;

4° L'enveloppe est pourvue à sa partie inférieure d'une ouverture (ordinairement fermée) qui, lorsqu'on interrompt l'arrivée de l'air froid du dehors, permet l'entrée de l'air de la salle. Par ce moyen on peut chauffer d'abord l'air de la pièce et ouvrir ensuite l'orifice de la prise d'air extérieur en même temps qu'on fait fonctionner les bouches de la ventilation.

Dans le système Peclet, la ventilation se produit toujours en même temps que le chauffage, en utilisant la cheminée du calorifère pour y faire déboucher les tuyaux d'appel, ainsi que nous l'avons dit plus haut.

En été, ou quand le calorifère ne fonctionne pas, le tirage s'obtient à l'aide d'un petit réchaud mobile que l'on dépose au bas de la cheminée par une ouverture que l'on ferme au moyen d'une porte.

On construit des poêles *Peclet* de diverses dimensions. On peut même transformer la plupart des poêles ordinaires en calorifères de ce système.

Pour les salles d'école contenant 6 mètres cubes par élève, la consommation de combustible par heure est indiquée comme suit selon la grandeur des salles :

Nombre d'élèves : 50 — 100 — 150 — 200 — 250 — 300.

Houille en kilogs : 2 — 3 — 4 — 5 — 6 — 7.

Pour le bois, la consommation serait à peu près double.

En continuant cette progression, on trouverait, par analogie, que la consommation de houille pour chauffer un hôpital partiel par le système Peclet, serait de 2880 kilogrammes par 24 heures.

POÊLES OUVERTS.

Ces poêles sont des foyers ouverts en fonte, en tôle, en porcelaine, etc., pourvus de tuyaux de conduite pour la fumée qui s'évacue comme dans les poêles ordinaires. Ils réunissent les qualités et les défauts que nous avons signalés aux articles précédents.

CALORIFÈRE A AIR CHAUD.

Ce système est économique, mais il exige des frais considérables pour son établissement. Le grand fourneau et les tuyaux nécessaires pour chauffer et conduire l'air chaud demandent parfois des réparations importantes qui interrompent le chauffage. En outre, si l'on peut profiter de la cheminée du fourneau pour produire l'appel nécessaire à la ventilation pendant l'hiver, on n'est pas dispensé, pendant l'été, d'y entretenir un foyer spécial pour lequel la consommation de combustible est comme nous l'avons vu, de 640 kilogrammes par 24 heures pour les quatre bâtiments.

Le fourneau du calorifère ayant une surface de grille invariable, il est fort difficile de régler la quantité de chaleur produite suivant la température de l'atmosphère.

Ce système utilise 0,50 pour cent de la puissance calorifique du combustible employé au chauffage.

CALORIFÈRE A VAPEUR.

Il faut pour ce système, un générateur, un développement de tuyaux pour la circulation de la vapeur et un second système de conduits pour l'évacuation de l'air vicié.

Les frais d'établissement pour le chauffage des salles par la vapeur sont donc assez élevés.

Ce système présente les mêmes inconvénients que le précédent. La vapeur doit, pour pouvoir circuler, posséder une tension d'au moins une atmosphère et demie, et avoir, par conséquent, une température plus grande que 100°. En ajoutant la chaleur latente, 531°, communiquée aux tuyaux par la condensation, ceux-ci auront un minimum de puissance calorifique trop grande pendant les époques du printemps et de l'automne.

Dans les foyers à vapeur, on ne doit compter, d'après M. Peclet, que sur 0,75 de la puissance calorifique du combustible. (Voir l'appendice.)

CALORIFÈRE A EAU CHAUDE.

Ce système demande, comme le précédent, un générateur et un double appareil de conduits, plus un réservoir supérieur dans lequel l'eau froide doit être introduite par un moyen mécanique.

Le générateur fonctionne, soit à basse, soit à moyenne, soit à haute pression, selon la hauteur à laquelle doit s'élever la circulation d'eau chaude. Dans le cas de nos hôpitaux partiels, cette hauteur irait à environ 23 mètres au-dessus du générateur et exigerait que la température de l'eau, à la partie supérieure, fût portée à 150° ou 200°; ce qui correspond à des pressions de 4 1/2 à 15 atmosphères.

CALORIFÈRE A VAPEUR ET A EAU CHAUDE.

L'appareil dont il s'agit est la combinaison des deux précédents. Mais l'eau étant déposée dans des réservoirs situés dans les salles à chauffer, la vapeur est amenée par des tuyaux qui traversent successivement tous les réservoirs. L'eau s'échauffe

par le contact des tuyaux; ou bien aussi, par la condensation de la vapeur. En tous cas, il est nécessaire d'établir une conduite de vapeur pour chaque étage. Le générateur peut n'être chauffé qu'à 1 1/2 atmosphère; mais son foyer ne peut utiliser que 0,75 de la chaleur produite par le combustible. En outre, une partie du calorique se perd dans le circuit avant d'arriver dans les salles.

CONSÉQUENCES.

En résumant l'examen qui précède des divers systèmes de chauffage, nous reconnaissons qu'aucun d'eux ne satisfait au programme que nous avons posé.

Si l'on procède par exclusion, on écarte d'abord les foyers et les poêles ouverts comme étant incompatibles avec la propreté et l'économie.

Ensuite les calorifères à air chaud, à vapeur et à eau chaude seront écartés parce qu'ils exigent des appareils dispendieux; qu'ils ne sont pas exempts du danger provenant d'un tuyau qui crève, ou d'une chaudière qui éclate; qu'il faudrait un appareil spécial pour chaque bâtiment, plus un foyer de réserve pour suppléer à celui qu'on devrait réparer; qu'enfin ces systèmes doivent être complétés par une cheminée d'appel ou par un système de ventilateurs, moyens qui sont également fort coûteux. (Voir l'appendice.)

Il resterait donc le chauffage par des poêles fermés, parmi lesquels on choisirait ceux perfectionnés au moyen du système Peclet.

En effet, les poêles constituent le mode de chauffage le plus économique et le plus facile à établir en le combinant avec un bon système de ventilation.

C'est également ce système de chauffage qui permet le mieux de proportionner la production de la chaleur dans les salles en raison des variations de température de l'atmosphère.

Mais il s'agit de choisir un bon système de poêle.

Dans une chambre contenant environ 100 mètres cubes d'air, le chauffage ayant lieu au moyen d'un poêle ordinaire en tôle, on a brûlé 20 kilogrammes de houille en 10 heures, c'est-à-dire 2 kilogrammes par heure!

Pour une salle contenant 4,000 mètres cubes, il faudrait donc brûler 80 kilogrammes de combustible par heure; ce qui ferait en 24 heures, 19,200 kilogrammes pour les 8 grandes salles d'un hôpital partiel; c'est-à-dire cinq fois la consommation indiquée pour les poêles Peccet.

Quant au nombre des poêles à employer, il dépend des dimensions du foyer et du développement du tuyau de conduite de la fumée. En outre, les grandes salles à chauffer étant superposées, nous verrons dans le chapitre suivant, comment il est possible de satisfaire au chauffage à l'aide de poêles servant pour tous les étages.

CHAPITRE IV.

Description du système de chauffage et d'aérage à adopter.

CHALEUR UTILE DU TUYAU D'UN POÊLE.

Un poêle ne chauffe pas seulement par son foyer; le tuyau dans lequel circule la fumée chauffe directement l'air ambiant, et l'on peut admettre que la quantité de chaleur qui passe à travers ses parois est proportionnelle à la différence des températures intérieure et extérieure.

En outre, d'après les expériences faites par M. Peccet sur des tuyaux en tôle, en fonte et en terre cuite, il résulte qu'un mètre carré de surface de tuyau laisse passer en une heure, pour une différence de température d'un degré :

3,93	unités de chaleur pour la tôle;
9,90	id. id. la fonte;
3,85	id. id. la terre cuite.

En sortant du foyer, la fumée possède une température d'environ 800°. Une bonne disposition de tuyau de conduite peut l'amener à n'avoir plus que 200° ou 100° avant de s'échapper au dehors; sa température moyenne est donc de 500° pendant la chauffe, et l'excès de température variera de 400 à 500°.

Pour un excès moyen de température de 450°, chaque mètre carré de surface de tuyau laisse passer en une heure :

$450 \times 3,93 = 1768,5$	unités de chaleur pour la tôle;		
$450 \times 9,90 = 4445$	id.	id.	la fonte;
$450 \times 3,85 = 1732,5$	id.	id.	la terre cuite.

Cette énorme différence des quantités de chaleur qui passent à travers la fonte et la tôle n'existe pas dans le chauffage par l'eau ou par la vapeur. (CLAUDEL.)

Lorsqu'un tuyau en fonte sert de cheminée, le poêle utilisant 0,80 de la puissance calorifique du combustible, on peut, dans la pratique, compter sur un mètre carré de surface de chauffe en fonte par 100 mètres cubes de salle à chauffer.

PERTE DE CHALEUR PAR LES PAROIS DES SALLES, ETC.

On pourrait rechercher les pertes de chaleur qui ont lieu par les murs, le sol, les vitres, etc.; mais ces calculs n'apprendraient qu'une chose pour le cas qui nous occupe: c'est que ces pertes de chaleur doivent être compensées dans tous les systèmes par un entretien convenable de l'activité des foyers.

Or, comme les poêles bien construits permettent d'augmenter ou de diminuer à volonté la chaleur produite, on sera toujours à même de régler la température des salles d'après l'état de l'atmosphère, de façon à conserver à l'intérieur une température moyenne constante.

DESCRIPTION DU SYSTÈME DE POËLE PROPOSÉ.

Nous avons vu, au chapitre III de la première partie, que dans chaque aile des hôpitaux partiels se trouvent superposées quatre grandes salles de 16 mètres de largeur.

Les plafonds de ces salles sont supportés par des colonnes en fonte dans lesquelles viennent s'assembler les poutrelles en fer formant la charpente des planchers et des combles.

Les colonnes en fonte, espacées de 4 mètres d'axe en axe, ont leurs fondations dans les caves et sont, en quelque sorte, autant de cheminées qui peuvent être utilisées pour le chauffage des salles.

En effet, la section de ces colonnes est celle d'un tuyau. Leurs parties correspondantes à la hauteur des étages peuvent être assemblées de façon à satisfaire à la résistance sans laisser de joint par où les gaz pourraient s'échapper.

Il suffirait donc que l'on fit du feu au pied de ces colonnes en les faisant servir de cheminées. Les produits de la combustion communiqueraient leur chaleur à la fonte dans tout leur parcours compté depuis les caves jusqu'au faite des combles.

La conductibilité du métal pour le calorique permettrait, non seulement de chauffer régulièrement les cheminées en fonte, mais aussi d'empêcher le refroidissement des planchers par suite de la chaleur qui serait communiquée aux poutrelles en fer assemblées dans les colonnes.

On peut se demander si la dilatation de la fonte des colonnes ne serait point un inconvénient nuisible à la stabilité du bâtiment?

La dilatation linéaire de la fonte est d'environ 0,0014 de 0° à 100° en prenant pour unité la longueur de la pièce.

Si la température moyenne des parois de la cheminée était de 300°, le coefficient serait 0,0033.

Pour 5 mètres, hauteur d'une colonne, l'augmentation de longueur serait $5 \times 0,0033 = 0^m 0165$.

Cette quantité serait sans effet sur un plancher porté par des poutrelles en fer laminé dont l'élasticité est très-grande.

D'ailleurs, le métal des colonnes-cheminées ne sera jamais chauffé au-delà de 150 à 200°; de sorte que la variation de

hauteur ne pourra être que de quelques millimètres à chaque étage.

Voici donc un système de calorifère qui atteindra le but : On fera du feu dans les petits foyers communiquant avec la base des colonnes dans les caves, et toutes les parties des salles recevront, par rayonnement, la chaleur accumulée dans les cheminées en fonte et dans toutes les parties métalliques adjacentes. (Pl. III, fig. 2 et 4.)

Par ce système, on ne fera du feu que dans les caves; mais on aura de la chaleur en quantité suffisante à tous les étages et dans toute l'étendue des salles.

Car il suffit de calculer convenablement le diamètre des colonnes et la surface de grille nécessaire aux foyers souterrains.

Il y a plus; c'est que ce système permettra de modérer la quantité de chaleur produite en raison de l'état de l'atmosphère.

En effet, dans les périodes du printemps et de l'automne on pourra ne chauffer qu'une colonne sur deux ou sur trois.

Ensuite, les foyers, construits en bonne maçonnerie réfractaire, auront à l'intérieur une forme conique, qui permettra l'usage de grilles de divers diamètres, dont les plus grands serviront pour les temps froids et les plus petits pendant les périodes moyennes.

On aura donc toutes les facilités pour régler la puissance calorifique du système.

Enfin pendant les époques de chaleur, on pourra également se servir des colonnes comme cheminées d'appel; car il suffira comme l'indique M. Peclet, de faire usage d'un petit fourneau portatif, ou même d'employer une lampe dont la flamme servira à chauffer la colonne d'air de la cheminée.

SYSTÈME DE VENTILATION.

Nous suivrons pour ventiler nos salles, les indications de M. Peclet en les appliquant aux quantités d'air que nous avons calculées dans nos études précédentes. (Pl. III.)

D'abord, nous avons prescrit des cheminées à pratiquer dans les pilastres des façades de nos bâtiments. Chaque pilastre renferme donc quatre cheminées correspondant chacune avec un étage.

Ces cheminées ayant leur orifice supérieur à la hauteur des combles, s'arrêtent au niveau du plancher de l'étage auquel elles doivent servir et, se raccordant avec des conduits horizontaux, amènent l'air frais dans des tambours en tôle formant enveloppe autour de la partie inférieure des colonnes à chaque étage. Ainsi, l'air froid, pris dans les couches supérieures, vient se chauffer entre la colonne et son enveloppe avant de se répandre dans la salle. (Pl. III, fig. 2 et 3.)

Mais, comme nous l'avons dit précédemment, les cheminées d'aérage auront chacune une seconde ouverture inférieure pratiquée dans le mur de la salle afin que, pendant l'été, on puisse laisser entrer l'air frais sans le faire passer par les enveloppes des colonnes.

Pour l'évacuation de l'air vicié, chaque colonne servira de cheminée d'appel. A cet effet, des tuyaux placés dans l'épaisseur du plancher et s'épanouissant en entonnoir dans le plafond, aboutiront à l'intérieur des colonnes où ils se relèveront verticalement sur une certaine hauteur afin que l'air appelé dans ces tuyaux par la chaleur, soit entraîné avec les gaz provenant du foyer. (Pl. III, fig. 2 et 3.)

En nous basant sur les calculs précédents, chaque colonne recevra deux tuyaux pour l'évacuation de l'air vicié. Chaque grande salle ayant 12 colonnes, il s'y trouvera donc 24 tuyaux d'appel. Les tuyaux d'aérage étant en même nombre que ces

derniers, on satisfera au principe qui prescrit de multiplier autant que possible les prises d'air et les ouvertures nécessaires à la ventilation de chaque point des salles.

DIAMÈTRE DES COLONNES.

Nous avons vu que, dans le chauffage au moyen de cheminées en fonte, un mètre carré de surface de chauffe suffit pour 100 mètres cubes de salle à chauffer.

Nous pouvons donc calculer les dimensions et la puissance calorifique de nos colonnes en fonte.

Mais, d'abord, ces colonnes doivent recevoir les dimensions convenables pour leur résistance comme supports isolés. Ensuite elles doivent avoir un diamètre suffisant pour contenir les deux tuyaux d'appel, ayant chacun une section d'un décimètre carré, et laisser un passage suffisant aux produits de la combustion du foyer. La section ordinaire des cheminées étant de 4 décimètres carrés, nous trouvons que le vide à former à l'intérieur des colonnes ne peut être moindre que 6 décimètres carrés.

Or, cette surface répond à un cercle de 0^m28 de diamètre. D'ailleurs, une cheminée peut avoir une section plus grande que celle nécessaire au passage des gaz, pourvu que sa hauteur soit suffisante et que l'on ait soin de pratiquer au sommet et près du foyer, les rétrécissements nécessaires pour empêcher les contre-courants. Il suffit que la construction de la cheminée soit telle que la fumée acquiert une vitesse assez grande pour résister à l'action du vent.

Si la section est un peu plus large qu'il n'est nécessaire, on a l'avantage d'éviter la diminution de vitesse occasionnée par le frottement des gaz contre les parois de la cheminée, au sommet de laquelle on peut, comme pour les fours à réverbère, placer un obturateur qui réglera le tirage selon les besoins.

Le régime du foyer étant établi d'une façon régulière, la quantité de chaleur C , communiquée à la cheminée en fonte dans l'unité de temps, sera une quantité constante.

Soit L la longueur de la cheminée qui reçoit la quantité de chaleur C ; R le rayon de la cheminée, et x la quantité de chaleur rayonnée par un centimètre carré de surface de chauffe.

On aura évidemment :

$$2 \pi R \times L \times x = C$$

$$x = \frac{C}{2 \pi R \times L}$$

Cette formule permet de trouver le rayon d'une cheminée capable de donner une quantité de calorifique x en fonction de C , R et L .

En outre, cette expression prouve que la quantité de chaleur émanée de chaque point de la surface de chauffe est en raison inverse du diamètre de la cheminée.

Par conséquent on pourrait calculer ce diamètre pour que la température ne soit pas trop grande dans le voisinage des cheminées. La quantité de chaleur totale rayonnée reste constante, mais le degré de température d'un point quelconque de la cheminée variera avec la circonférence.

Supposons que la cheminée ait une circonférence extérieure de 1^m00 ce qui donne 0^m32 de diamètre et une épaisseur de 0^m02 pour les parois en fonte; la hauteur des plafonds étant 5^m00, chaque colonne aura 5 mètres carrés de surface de chauffe. Les 12 colonnes d'une salle auront 60 mètres carrés. Mais comme les expériences sur lesquelles nous nous sommes appuyés furent faites pour des tuyaux de 10 à 20 centimètres de diamètre, afin de rester dans ces conditions nous réduirons d'un tiers la puissance calorifique de nos colonnes. Ainsi, au lieu de compter 100 mètres cubes d'air par mètre carré de surface de chauffe, nous n'admettrons que 66 mètres cubes.

Une grande salle contenant $4,000^m^3$ d'air, si l'on divise ce nombre par 66, on trouve 60 mètres carrés environ. Ce résultat confirme nos prévisions.

CONSOMMATION DE COMBUSTIBLE POUR UN HÔPITAL PARTIEL.

Nous avons vu qu'un poêle mal construit pouvait consommer deux kilogrammes de houille par heure.

Supposons qu'un tel poêle soit placé au pied de chaque colonne pour le chauffage de notre hôpital partiel.

Puisque nous avons 24 colonnes, il y aura 24 poêles qui brûleront chacun 2 kilogrammes de houille par heure, ou ensemble 48 kilogrammes dans le même temps. Pour 24 heures la consommation sera donc de $24 \times 48 = 1152$ kilogrammes.

Ainsi la quantité de houille qui serait nécessaire au chauffage d'un hôpital partiel au moyen du système que nous proposons, ne serait guère que le tiers de la consommation trouvée pour le système Peclet, et le quinzième seulement de la quantité de combustible qu'il faudrait consommer en chauffant les salles à l'aide de poêles ordinaires.

ENTRETIEN DE L'ÉTAT HYGROMÉTRIQUE DE L'AIR DANS LES SALLES.

Comme le chauffage et la ventilation combinés peuvent diminuer la quantité de vapeur d'eau contenue dans l'air des salles, on remédiera à cet inconvénient en disposant, sur la base supérieure des enveloppes à air chaud, des godets dans lesquels on verse environ deux litres d'eau par 100 mètres cubes d'air.

CHAUFFAGE ET VENTILATION DES CORRIDORS, DES CAGES D'ESCALIERS, DES LATRINES, ETC.

Le système de chauffage et de ventilation que nous venons d'étudier nous paraît être assez simple et assez avantageux

pour être appliqué dans toutes les parties d'un bâtiment. On pourra donc l'employer pour chauffer et ventiler le vestibule, les corridors, les cages d'escaliers et les latrines de chaque hôpital partiel.

DÉPENSES A FAIRE POUR LA CONSTRUCTION D'UN HÔPITAL MILITAIRE POUVANT CONTENIR 3,000 HOMMES.

En supposant que l'état possède le terrain nécessaire à l'emplacement d'un hôpital, on peut estimer à fr. 700,000, la somme à dépenser pour l'érection des bâtiments et des locaux indiqués dans le projet que nous avons étudié.

APPENDICE.

Nous ne pouvons méconnaître que le chauffage par la vapeur, et la ventilation par insufflation, à l'aide de ventilateurs, ne soient avantageux sous plusieurs rapports, comme on peut s'en assurer par les notes ci-dessous que M. le capitaine du génie bavarois Korbling a eu la bonté de nous communiquer :

1° Le prix de tous les appareils pour le chauffage à vapeur avec une ventilation par insufflation de 60 mètres cubes d'air par homme et par heure, ainsi que pour la buanderie à vapeur et pour chauffer l'eau des bains, monte à 170 francs par homme dans l'hôpital de la guerre à Ingolstadt.

Les mêmes appareils à vapeur pour le chauffage et la ventilation, pour la cuisine à vapeur, pour la blanchisserie et les bains feraient une dépense d'environ 600,000 francs pour un hôpital de 4,000 hommes;

2° La grandeur des salles peut être à volonté;

3° Les dimensions des salles des malades à Ingolstadt, pour 10 hommes ou pour 10 lits, sont de 10 mètres de longueur, 7 mètres de largeur et 4 mètres de hauteur;

4° Les résultats du chauffage et de la ventilation par insufflation sont les suivants :

Pour insufler 27,000 mètres cubes d'air par heure pour 450 hommes; pour chauffer toutes les salles à environ 20°; pour faire mouvoir la machine à vapeur, la ventilation, la roue de lavage, l'hydroextracteur, la pompe d'eau et la calandre de la blanchisserie, on a besoin de 135 kilogrammes de houille par heure; ce qui fait en 15 heures, une consommation de 2,000 kilogrammes de houille, environ 4^e 50 par homme et par jour.

Dans cette quantité de combustible est comprise aussi la vapeur nécessaire pour la blanchisserie et le chauffage de l'eau pour les bains.

Les appareils furent établis par M. Jean Haag, ingénieur civil et fabricant de machines à Augsburg.

L'efficacité de ce système est telle que le nouveau bâtiment (qui est voué à l'épreuve) fut tout-à-fait séché aussitôt après sa construction.

Si l'on comptait, pour notre hôpital, une consommation de 4^e 50 par homme et par jour, il faudrait pour 3,000 hommes, 13,500 kilogrammes de houille pour les besoins journaliers du service.

Selon nous, l'inconvénient principal d'un système aussi largement établi, appliqué à notre hôpital serait dans son inutilité en temps de paix.

Car les grands hôpitaux dont nous nous occupons ne doivent être créés que pour servir en temps de guerre, et il serait regrettable de laisser se rouiller des machines et des appareils coûteux qui resteraient sans fonctionner en temps ordinaire.

Nous croyons donc que tout en appréciant les services que le chauffage à vapeur et l'aérage par insuflation peuvent rendre dans les édifices d'un usage permanent, il y a lieu de préférer un système plus simple et plus économique pour les bâtiments qui, en temps de paix, peuvent être destinés à divers services.

Car nous distinguons les hôpitaux militaires en deux catégories : 1^e les hôpitaux des garnisons et 2^e les hôpitaux des grands pivots stratégiques.

Les premiers étant toujours occupés conformément à leur destination, peuvent être dotés de tous les perfectionnements procurés par l'industrie.

Les seconds, ne devant être employés spécialement qu'en temps de guerre, doivent satisfaire aux besoins du service par des moyens plus naturels et plus faciles à utiliser.

En effet, on peut trouver de grands avantages à utiliser le chauffage par la vapeur et les machines à ventiler dans les hôpitaux ordinaires, constamment dirigés par des employés exercés à se servir des mécanismes. Mais pour les grands hôpitaux dont les bâtiments peuvent être affectés, en temps de paix, au logement des troupes, aux écoles, aux magasins d'habillements, etc., on doit, selon nous, produire la ventilation au moyen de cheminées d'appel et chauffer les salles par des poêles perfectionnés. C'est, comme on le voit, nous rallier entièrement au système que M. Peclet a prescrit pour les bâtiments d'école.

D'ailleurs notre préférence pour ce système se justifie :

- 1^e Par sa simplicité;
- 2^e Par le peu de dépense qu'il exige;
- 3^e Par la possibilité de l'établir dans un bâtiment quelconque.

FIN.

FIG. 4

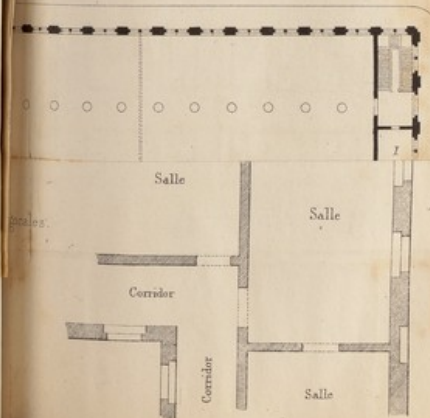
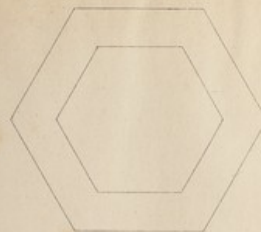


FIG. 6

PROJET D'HÔPITAL MILITAIRE

par E.P.J. Piron, Capitaine du Génie.

FIG. 1

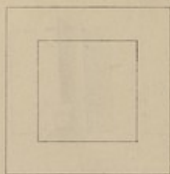


FIG. 2



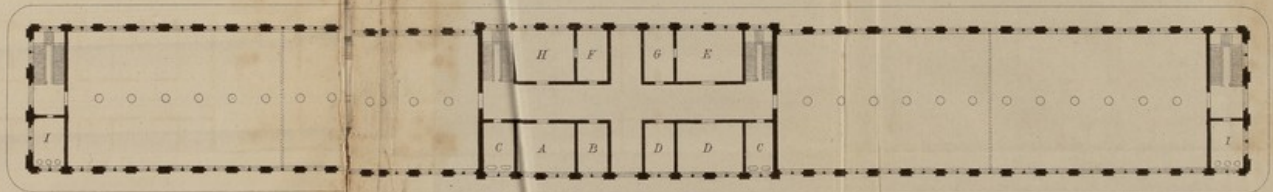
FIG. 3



FIG. 4



Plan du Rez-de-Chaussée d'un hôpital partiel.



0 5 10 20 30 40 50 mètres

FIG. 5



A. Logement des infirmiers.
B. id. de l'infirmerie-major.
C. Bains et Lavoirs.
D. Magasin et Ringerie.
E. id. des états militaires.

F. Médecin de garde.
G. Pharmacien id.
H. Salles pour les opérations chirurgicales.
I. Latrines.

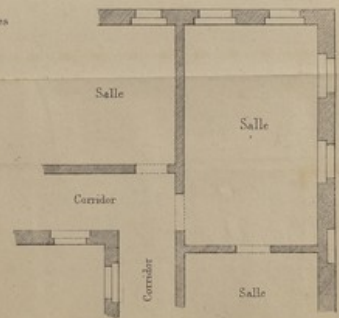
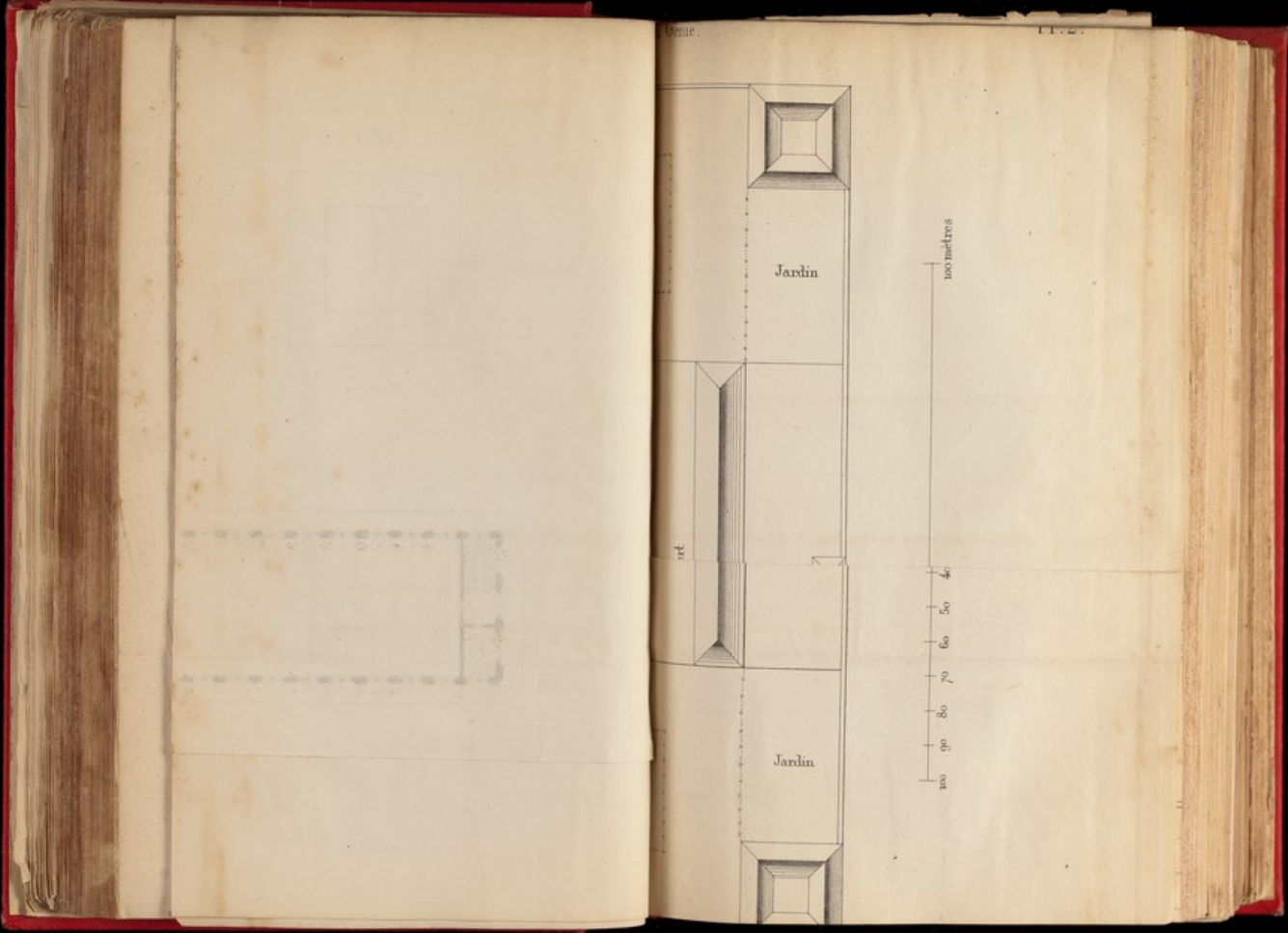
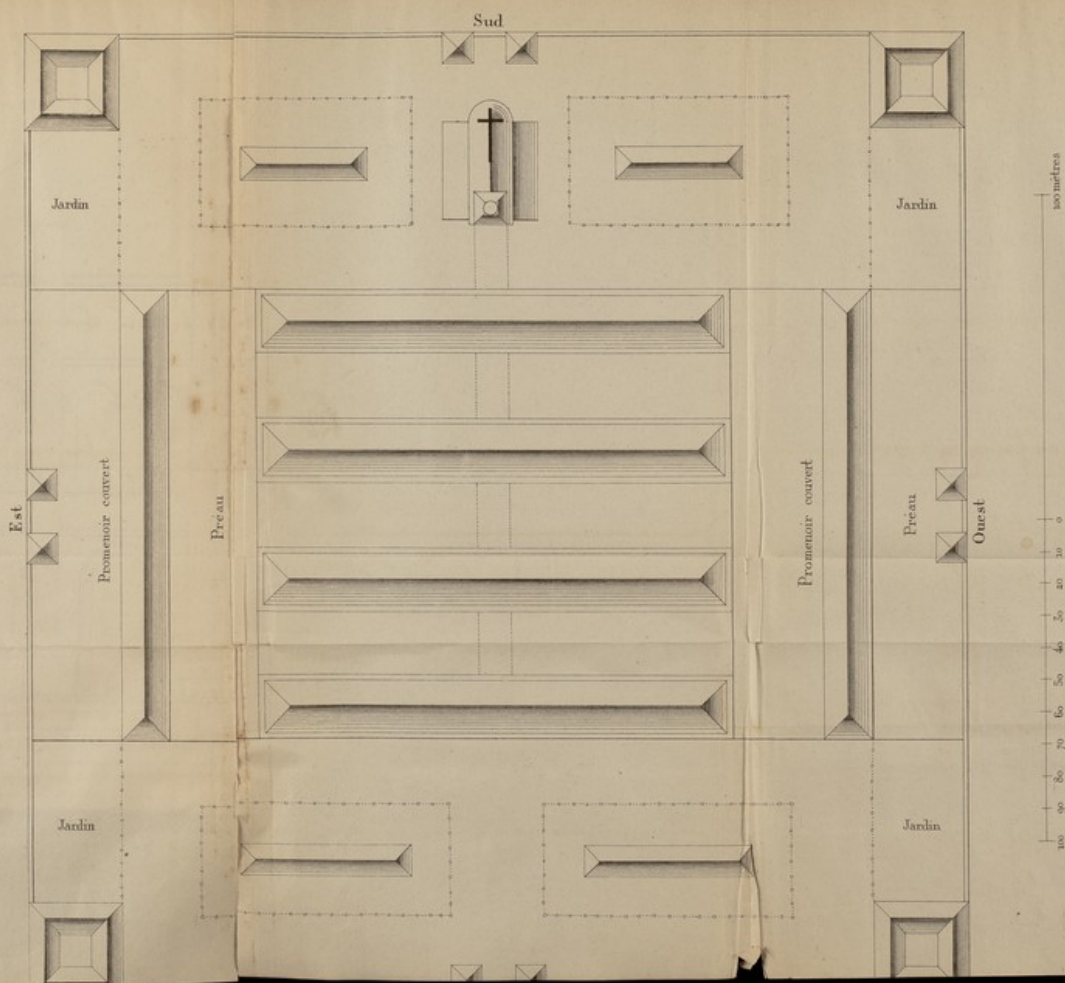
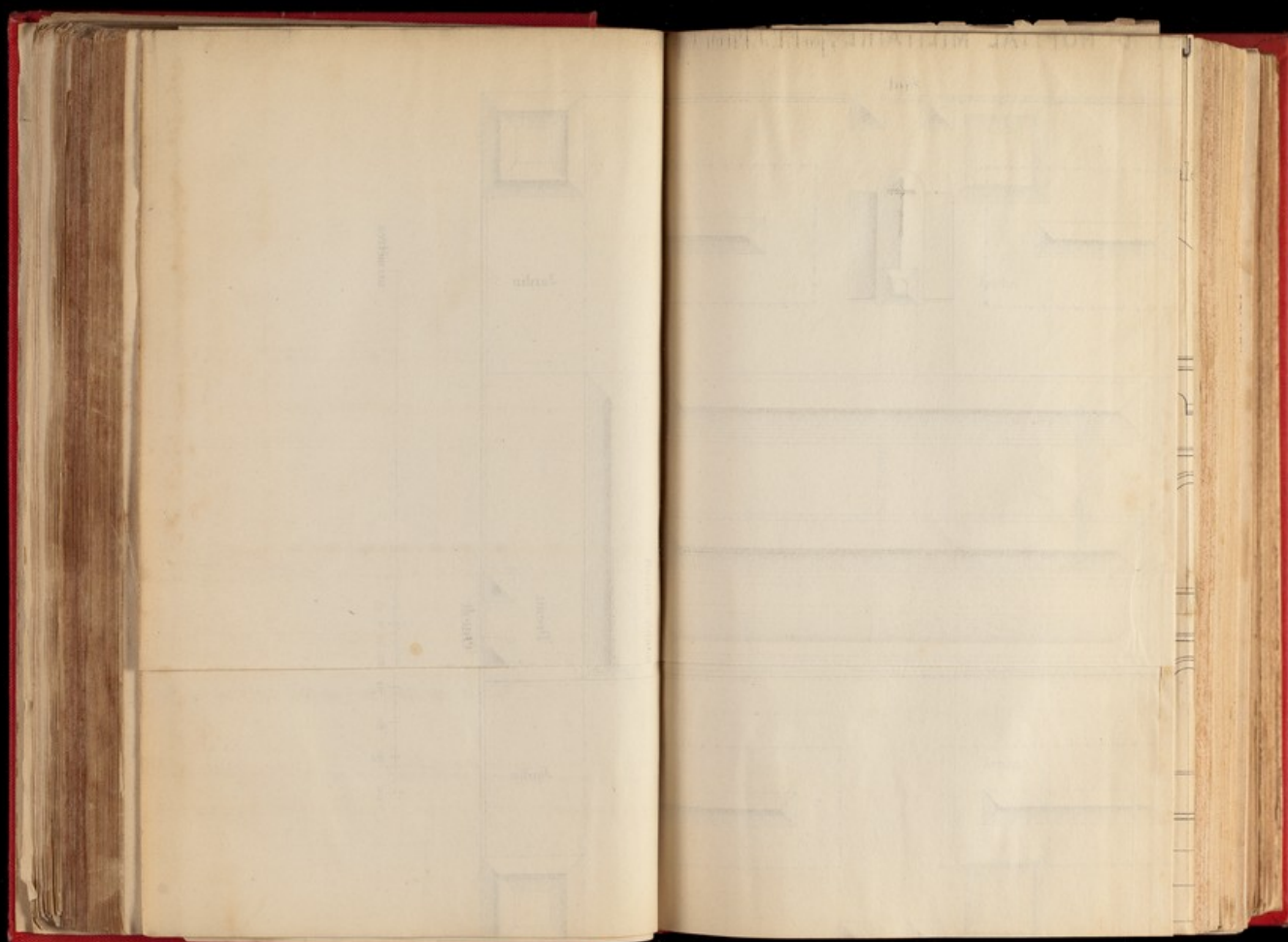


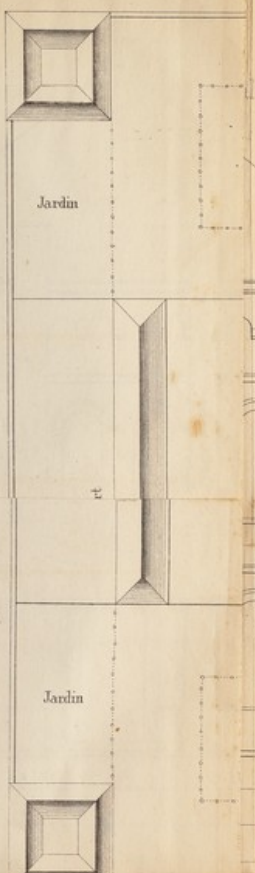
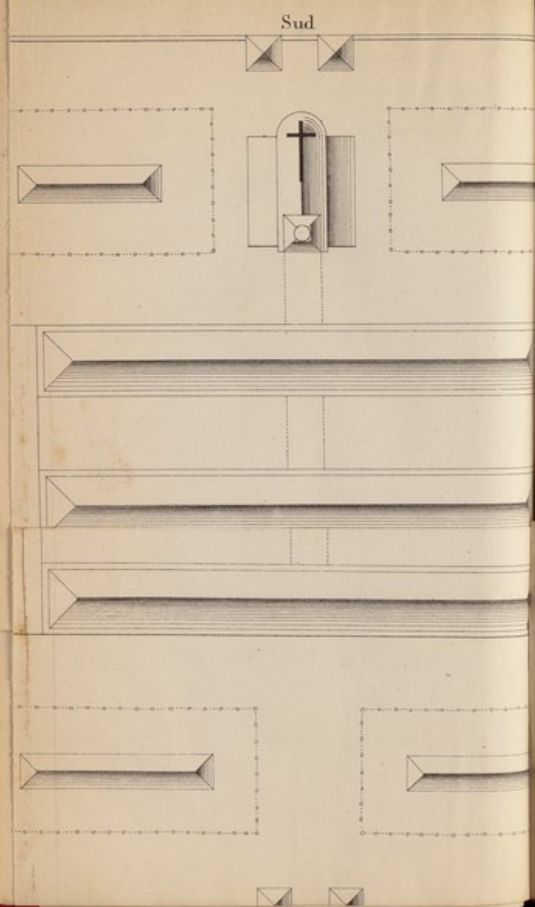
FIG. 6



Plan d'ensemble
d'un hôpital militaire pour 3000 hommes







ble
d'un ar 5000 hommes

Fig. 125. - Hôpital

PROJET D'HOPITAL MILITAIRE par F. P. J. Piron, Colonel du Génie.

FIG. 1
Elevation latérale

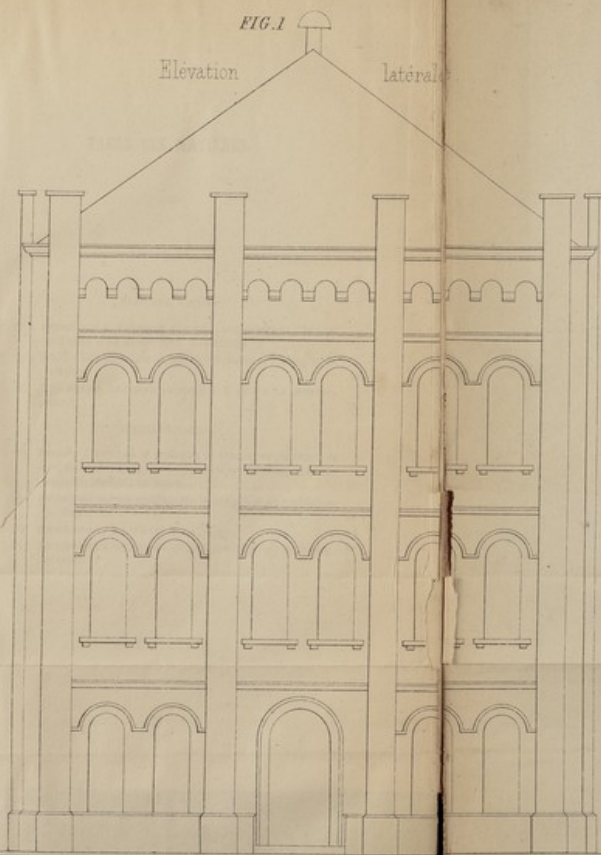


FIG. 1 et 2 0 1 2 3 4 5 6 7 8

FIG. 4 0 1 2

FIG. 5 0 1

10 mètres

5 mètres

2 mètres

FIG. 5

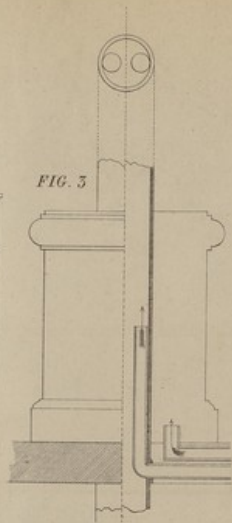


FIG. 4

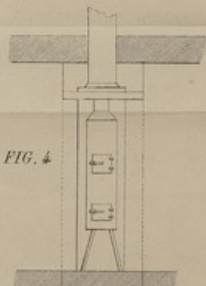
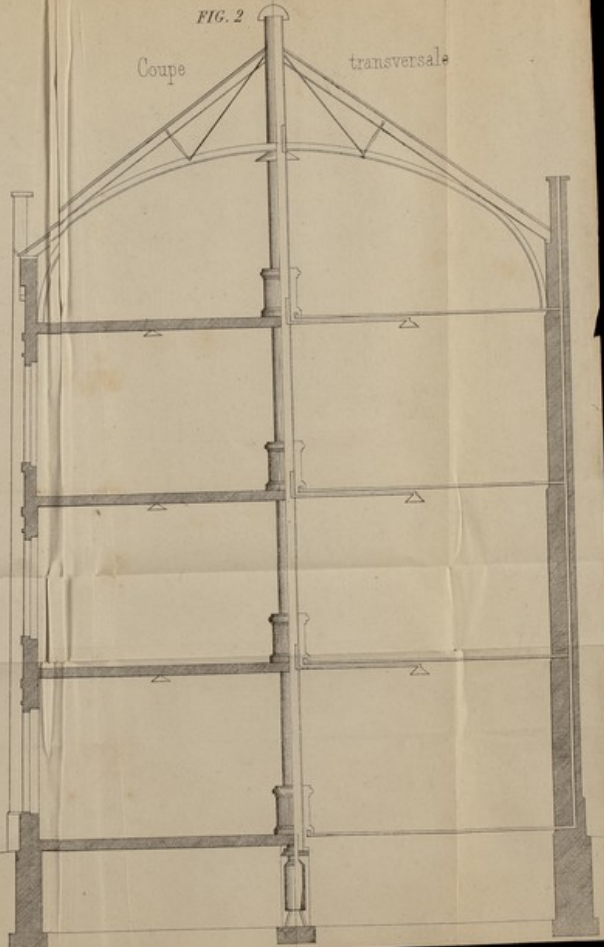


FIG. 2
Coupe transversale



PROJ

FIG. 1

Elevation

latérale

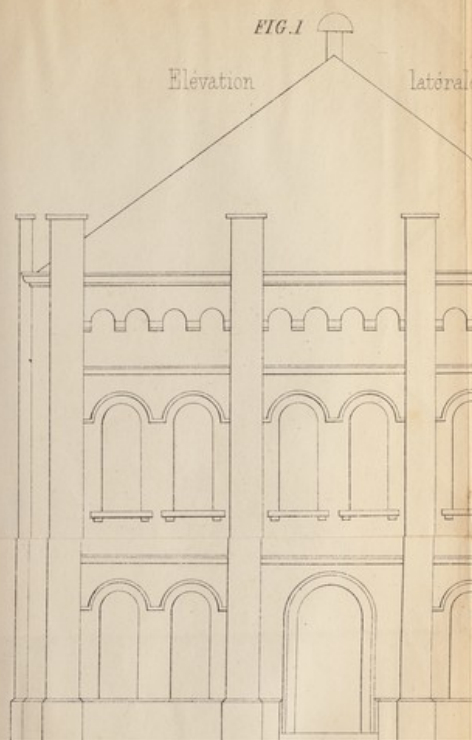


FIG. 1 et 2 0 1 2 3 4 5 6 7 8

FIG. 4 0 1 2

FIG. 5 0 1

ET

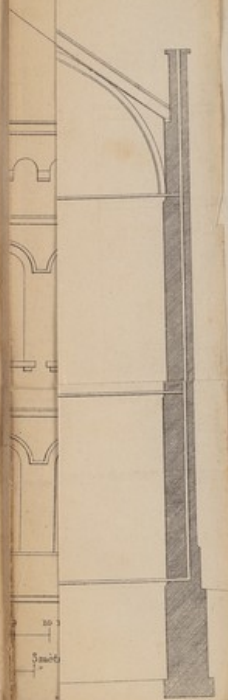


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ESSAI

AUX

LES HOPITAUX

DIMENSIONS

EMPLACEMENT, CONSTRUCTION, AÉRATION,
CHAUFFAGE ET VENTILATION.

CH. S. AZIN,

Professeur agrégé de la Faculté de médecine de Strasbourg, Répétiteur de chirurgie,
à l'École impériale de médecine militaire.

AVEC 11 FIGURES

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LIBRAIRES DE L'ACADÉMIE IMPÉRIALE DE MÉDECINE,

Rue Haute-Ville, 49.

1865

LES HOPITAUX

EXTRAIT

ANNALES D'HYGIÈNE PUBLIQUE ET DE MÉDECINE LÉGALE,
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Publié depuis 1829, tous les trois mois, par cahier de 250 pages avec planches.

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ESSAI

SUR LES HOPITAUX

DIMENSIONS,

EMPLACEMENT, CONSTRUCTION, AÉRATION,
CHAUFFAGE ET VENTILATION.

Rien ne fait désirer le bien, comme la vue continuelle du mal. Appelé tous les jours par notre service à l'hôpital civil de Strasbourg, nous avons sous les yeux la réunion de tous les défauts que peut présenter un hôpital; nous sommes naturellement porté vers l'étude de l'hygiène hospitalière, en constatant à chaque pas les dispositions antihygiéniques qu'il présente. La question des hôpitaux est, du reste, à l'ordre du jour; elle a soulevé à Paris des discussions vives et souvent violentes; elle a donné le jour à de nombreux travaux, à de savantes recherches que l'on ne saurait consulter sans intérêt. On a vu se heurter, sur les ruines de l'Hôtel-Dieu, la philanthropie passionnée, l'amour du progrès et de l'innovation, les exigences exagérées d'une part, de l'autre l'esprit d'ordre poussé jusqu'à la routine, toujours conservateur et souvent logique, et le respect des traditions bonnes ou mauvaises. On a vu aussi des chirurgiens distingués devenir des administrateurs médiocres et des administrateurs que nous ne nous permettrons pas de juger trop, s'occuper des questions médicales.

Pour ne pas mériter, nous aussi, le reproche de ne pas savoir rester dans le rôle qui nous appartient, nous ne nous mêlerons pas à une polémique qui, du reste, semble aujourd'hui à peu près terminée. Nous traiterons les questions relatives à l'hygiène hospitalière d'une façon générale et en quelque sorte abstraite, en n'effleurant qu'à peine l'économie administrative et nous profiterons pour nous guider des fautes commises dans les discussions ayant trait à la reconstruction de l'Hôtel-Dieu, car l'erreur aussi a ses enseignements.

Nous sommes toutefois des premiers à apprécier la valeur des nombreux documents que contiennent les travaux de Husson, de Blondel et Ser et d'Antony Rouillet, bien qu'ils ne soient pas dus à des plumes suffisamment médicales, et nous avons suivi avec le plus vif intérêt les discussions soulevées au sein de l'Académie de médecine et de la Société de chirurgie au sujet de l'hygiène des hôpitaux. Nous avons profité de tous ces travaux auxquels nous empruntons, plutôt qu'à notre expérience insuffisante, les quelques pages que nous écrivons.

Rendons aussi l'hommage qui leur est dû à Oppert et à Esse de Berlin ainsi qu'à un savant hygiéniste américain, médecin militaire, dont nous taïrons le nom, jusqu'à ce qu'il ait obtenu la réhabilitation que lui doit son pays. C'est un douloureux exemple des dangers que court le médecin qui se croit administrateur. Puissent les administrateurs qui tranchent témérairement les questions d'hygiène hospitalière, ne pas rencontrer une aussi cruelle punition, si leur insuffisance était un jour reconnue.

I. — Dimensions que l'on peut donner aux hôpitaux.

Quelles sont les dimensions que l'on peut donner aux établissements hospitaliers? Y a-t-il des limites maximum ou minimum que l'on ne saurait dépasser sans danger?

Telles sont les premières questions qui se présentent à nous dans l'étude que nous abordons. Elles sont grosses de discussions et d'orages.

Il est tout d'abord évident que les ressources des établissements hospitaliers doivent être en rapport avec les besoins de la population indigente ou militaire qu'ils sont appelés à desservir. Ces besoins sont sujets à des variations fréquentes et considérables, soit en temps de paix, par le fait des épidémies, soit en temps de guerre, par le fait des batailles et surtout des maladies qu'engendrent la fatigue et les privations des troupes. Les établissements hospitaliers devront être assez considérables, ou assez nombreux et assez abondamment pourvus de tout, pour subvenir, non seulement aux besoins ordinaires, mais encore dans les limites du possible, aux nécessités impérieuses qu'engendrent les calamités publiques. Mais ces ressources, une fois réunies par les soins des particuliers, de la charité publique et des gouvernements, faut-il les morceler et construire des hôpitaux relativement petits, nombreux et séparés les uns des autres, ou bien est-il préférable de les réunir dans un grand hôpital? La préférence à accorder à tel ou tel système doit-elle dépendre des questions d'économie ou des questions de salubrité? Y a-t-il des dimensions que l'on ne doit pas dépasser? Est-il possible de concilier l'hygiène hospitalière avec la parcimonieuse sagesse des administrateurs?

Il a été démontré, et il est admis, que les malades et les blessés guérissent mieux dans les petits hôpitaux que dans les grands, toutes les autres conditions étant égales d'ailleurs; mais on reproche aux petits établissements d'élever considérablement les frais d'installation et le prix de journées des malades, point capital lorsque les ressources sont limitées. On leur reproche aussi de rendre la surveillance disciplinaire et administrative difficile et de nécessiter des déplacements coûteux et préjudiciables aux malades, lors-

qu'ils sont appelés à desservir des centres de population considérables et éloignés.

Peut-on satisfaire à la fois aux exigences du médecin qui est chargé de la santé des malades qui lui sont confiés et à celles des administrateurs responsables des deniers publics?

On a souvent cherché à réaliser ce difficile problème, on n'y est pas parvenu jusqu'ici d'une façon tout à fait satisfaisante. Les principes auxquels on s'est arrêté de nos jours sont les suivants : Il faut que les malades soient traités dans de petits hôpitaux, c'est ce qu'imposent les statistiques, et grouper ceux-ci autour d'un centre administratif, afin qu'ils participent aux avantages d'économie qui sont l'apanage des grands établissements : en les rapprochant ainsi, il ne faut nuire, ni à leur isolement, ni à leur indépendance, ni à leur bonne exposition : d'un autre côté, leur éloignement ne doit pas être tel qu'il devienne une gêne pour la facilité et la régularité du service.

C'est donc par le choix judicieux du plan de l'hôpital qu'il sera possible de lui assurer les avantages hygiéniques et administratifs réunis ; mais en groupant ainsi des bâtiments séparés autour d'un centre commun, ne court-on pas risque de retomber dans les défauts que présentent les grands hôpitaux. C'est ce qui est arrivé chaque fois que l'espace dont on disposait n'était pas assez étendu pour permettre un isolement suffisant des pavillons séparés dont se compose l'hôpital. L'expérience a démontré que la distance à conserver entre eux doit être plus considérable qu'on ne le croyait tout d'abord. On a reconnu aussi qu'en espaçant les pavillons, on diminue le danger sans le conjurer d'une façon absolue. Il reste donc indiqué de toujours réduire autant que possible le nombre des malades traités dans le même établissement.

Quelle sera la population de chacun des pavillons ? Il est difficile de préciser des chiffres ; le nombre des malades, on

le comprend, ne saurait être fixé d'une manière mathématique ; les avis du reste ont varié. Les moyennes qui nous semblent les plus acceptables, celles qui ont l'approbation de la majorité, sont 100 ou 50 ; dans le premier cas, le bâtiment doit être double et séparé au milieu par une vaste cage d'escalier et par des chambres de service isolant les deux ailes ; il se trouve alors formé par deux pavillons accouplés.

Cette question du reste se représentera à nous lorsque nous parcourrons les différents plans qui ont été adoptés jusqu'ici dans la construction des hôpitaux, et lorsque nous nous occuperons des dimensions que l'on doit accorder à chacun des bâtiments. Jusque-là nous ne pouvons avoir la prétention que d'indiquer des chiffres tout à fait approximatifs dont on s'est trop souvent éloigné. Prenons quelques exemples :

L'hôpital de Lariboisière, construit récemment d'après les idées que nous venons d'énoncer et au sujet duquel on a tant discuté, est formé par des pavillons séparés contenant chacun 102 lits. Les pavillons sont simples et reliés par des couloirs. Les nouveaux bâtiments du Val-de-Grâce, dans lesquels sont situés les services cliniques, sont des pavillons doubles et symétriques ; ils contiennent environ 150 malades : c'est un chiffre un peu élevé. Le même reproche s'applique à l'hôpital de Vincennes dont les pavillons, plus étendus encore, sont destinés à abriter sous le même toit plus de 300 malades. Lorsque s'éleva dans la Société de chirurgie, la discussion ayant trait à la reconstruction de l'Hôtel-Dieu, Trélat demanda que les pavillons ne contiennent pas plus de 100 lits ; ce chiffre fut accepté comme limite maximum par la plupart des membres de la savante société. Nous croyons qu'il serait utile, si faire se peut, de le réduire encore.

C'est la voie qui a été suivie par les Anglais pour les hôpitaux militaires de Woolwich et de Malte. Chacun des pavil-

lons dont se composent ces établissements ne comporte que 40 ou 60 lits, chiffre bien différent de celui que l'on trouve dans leurs hôpitaux civils, de construction plus ancienne. Quant aux Américains, ils ont poussé le système jusqu'à ses dernières limites. Dans la sanglante guerre, où le Nord a triomphé, ils ont formé, avec des pavillons séparés contenant de 25 à 50 lits, des hôpitaux appelés à recevoir près de 4000 malades. Hammond nous apprend que ces vastes établissements n'ont pas été défavorables au traitement des malades et des blessés, grâce à l'heureuse disposition des plans qu'on avait adoptés pour leur construction. Il semble toutefois évident que, malgré tout ce que l'on pourra faire, de telles agglomérations de malades ne peuvent être que dangereuses. De même qu'il faut restreindre le nombre de lits par pavillon, de même on doit limiter le plus possible le nombre des pavillons dont se compose l'hôpital. Les impérieuses nécessités de la guerre peuvent seules autoriser la construction d'établissements semblables aux hôpitaux provisoires d'Amérique.

Quant aux maternités, c'est une question si pénible à envisager et si difficile à résoudre que nous osons à peine l'aborder. Dans celles qui sont les mieux disposées et les moins considérables, la mortalité est encore effrayante et hors de toute proportion avec ce qui s'observe hors des hôpitaux (1). Il est très-difficile de dire, même approximativement, les dimensions qu'il est permis de leur donner. Tout porte à croire que l'on ne pourra jamais trop les multiplier ni trop réduire le nombre des femmes que reçoit chacun de ces établissements.

(1) Voyez l'intéressant mémoire de St. Tarnier sur *l'Hygiène des hôpitaux de femmes en couches*. Paris, 1865.

II. — Choix de l'emplacement.

Rien n'est facile comme de désigner d'une façon abstraite l'emplacement que l'on doit choisir pour la construction d'un hôpital; mais dans la pratique surgissent des difficultés nombreuses et inattendues.

Les conditions que l'on est en droit d'exiger, n'ont pas toutes la même importance. Il faut une vaste étendue de terrain, même pour un hôpital de dimensions moyennes, autant que possible hors de l'enceinte des villes, en dehors même des faubourgs et dans un point où l'on n'a pas à craindre l'affluence rapide de la population, dont le mouvement excentrique et continu tend à envahir les abords des villes. La plupart des hôpitaux de Londres étaient situés au début aux limites extrêmes de la banlieue, entourés de champs cultivés ou de terrains vagues. Aujourd'hui ils ne sont plus même excentriques, et enveloppés de tous côtés par des bâtiments et des fabriques; ils prennent leur part des brouillards et de la fumée de cette grande cité.

On doit choisir pour l'emplacement d'un hôpital un endroit élevé. Une colline vaut mieux qu'une plaine, le fond d'une vallée n'est pas acceptable, la ventilation et l'aération n'y sont jamais suffisantes et l'humidité y est extrême. Ce sont des reproches que l'on fait, non sans grande apparence de raison, à l'emplacement de l'Hôtel-Dieu à Paris. L'hôpital doit être bien découvert au midi et à l'est et autant que possible abrité du côté du nord dans les pays froids. Cette dernière condition, à laquelle les Allemands semblent attacher une certaine importance (1), ne nous paraît pas mériter grande considération; nous préférons permettre aux vents régnant habituellement dans le pays de largement balayer les façades des pavillons.

(1) Voy. docteur Esse, *Die Krankenhäuser*. Berlin, 1857.

Le sol doit être sec, de nature calcaire ou granitique, le drainage doit s'y faire naturellement. Tout drainage artificiel est dispendieux et insuffisant. Il faut que l'on puisse trouver dans le voisinage de l'eau potable en abondance, c'est là une des conditions les plus indispensables, aussi le voisinage d'une rivière, dont les eaux claires coulent rapidement, est un précieux avantage. On pourra, en outre, profiter du courant pour éloigner de l'établissement les immondices et les eaux ménagères.

Le voisinage des marais, des rizières, des terrains bas et humides, doit être évité, et il en est de même des canaux et des eaux dormantes surtout si elles reçoivent les égouts d'une grande cité. Citons ici comme exemple le bras mort de la Seine, dont les eaux croupissantes ont été signalées de tout temps comme une des causes de l'insalubrité de l'Hôtel-Dieu.

On a demandé aussi que les hôpitaux soient établis assez près d'un chemin de fer, pour qu'ils puissent communiquer et s'approvisionner facilement au dehors. Ce voisinage qui, lorsqu'il n'est pas immédiat, ne saurait avoir aucun inconvénient, n'a d'importance que pour les établissements qui sont appelés, par la nature de leurs services, à recevoir ou à envoyer des évacuations de malades nombreuses ou fréquentes. Dans notre dernière guerre d'Italie, les voies ferrées ont rendu les plus grands services pour le transport des blessés, et les grands hôpitaux provisoires d'Amérique ont tous été établis sur les chemins de fer qui conduisaient au siège des hostilités. Peut-être viendra-t-il un jour où l'administration des hôpitaux de Paris traitera ses malades loin de la capitale, ne conservant plus dans la ville que des ambulances, situées près des grandes lignes de chemin de fer, et destinées aux secours urgents et au petit nombre de ceux à qui le transport serait préjudiciable.

Il est aussi un certain nombre de considérations invo-

quées au sujet du choix de l'emplacement, qui sont tout à fait inadmissibles. On veut compléter l'ornementation d'un quartier en y construisant un grand bâtiment public; c'est un hôpital qu'on y place. Le bon sens proteste contre l'idée de faire d'un hôpital un brillant et malsain décor.

Combien la verve gauloise ne s'est-elle pas exercée sur ce même Hôtel-Dieu mis à l'ombre de Notre-Dame. La superstition et le sentimentalisme ne sauraient entrer en ligne de compte lorsqu'il s'agit de construire un hôpital, et l'ombre d'une église, fût-elle même assez éloignée, ne saurait pas plus guérir un malade que les messes, les prières et les neuvaines. Le voisinage d'un évêché n'est guère plus utile; ce n'est pas dans les hôpitaux qu'on rencontre les évêques.

Il est, par contre, un certain nombre de questions administratives qui méritent d'être prises en sérieuse considération. On veut que les hôpitaux soient près des centres de population qu'ils sont appelés à desservir. Les malades graves et les blessés ne peuvent pas aller chercher au loin les secours qui leur sont nécessaires. Tant qu'on n'aura pas surmonté les difficultés que présente l'évacuation méthodique des malades, les établissements hospitaliers devront être près des quartiers populeux; mais il n'est nullement nécessaire qu'ils soient au milieu même de l'agglomération, et tant qu'il ne faudra pas pour les atteindre plus d'une demi-heure de marche, les malades pourront facilement s'y rendre ou s'y faire transporter.

Les motifs d'économie ont aussi une certaine importance. On peut, faute de ressources suffisantes, être forcé de bâtir sur les terrains que l'on possède. En général, plus on s'éloigne des centres de population, plus il est facile d'obtenir à bas prix un emplacement d'une étendue suffisante. La question d'économie favorisera donc, presque toujours, le choix auquel nous nous sommes arrêtés.

Enfin, lorsqu'il s'agit de legs faits aux hôpitaux, la volonté

du donataire doit être respectée. Il est curieux de voir que la plupart de ceux qui font ce dernier acte de bienfaisance suprême, imposent souvent aux administrateurs des conditions fâcheuses qui limitent ou annulent leurs bienfaits.

III. — Plans des pavillons et des hôpitaux.

Aucun système bien arrêté ne semble avoir présidé à la construction des hôpitaux antérieurs au XIX^e siècle. Les conditions hygiéniques, si difficiles à réaliser, et si indispensables à des établissements destinés à contenir une agglomération de malades, étaient abandonnées aux soins exclusifs des architectes qui ne suivaient guère que leurs fantaisies artistiques. Il suffit de parcourir le savant ouvrage de M. Husson, pour reconnaître, dans les nombreux plans qu'il contient des hôpitaux anciens, l'absence de toute méthode et l'ignorance des grands principes de l'hygiène hospitalière. C'est peu d'années avant la révolution française que la question des hôpitaux entra dans la voie scientifique où elle est aujourd'hui.

En 1786, une commission prise dans le sein de l'Académie des sciences fut chargée d'étudier les moyens d'obvier aux fâcheux effets de l'encombrement dans les salles de l'Hôtel-Dieu. Elle comptait parmi ses membres Tenon, Bailly, Lavoisier, Daubenton, La Place, Darcet, etc. C'est elle qui posa les premiers principes de l'hygiène hospitalière abandonnée jusque-là à des maçons. Vers la même époque les mémoires remarquables de Tenon (1) et de Bailly (2) firent faire de nouveaux progrès à cette science nouvelle. Puis se succédèrent de nombreuses commissions

(1) Tenon, *Mémoires sur les hôpitaux de Paris*, Paris, 1788.

(2) Bailly, *Extrait des registres de l'Académie royale des sciences*, du 22 nov. 1786; *Rapport des commissaires chargés, par l'Académie, de l'examen d'un projet d'un nouvel Hôtel-Dieu*, Paris, 1787.

médicales et administratives, des rapports, des mémoires et des discussions qui continuent encore de nos jours à émouvoir l'Académie de médecine et la Société de chirurgie.

De même que c'est nous qui avons les premiers reconnu et publié les grands principes de l'hygiène hospitalière, de même aussi c'est nous qui les premiers avons cherché à les mettre en pratique. Si nos hôpitaux laissent beaucoup à désirer sous certains rapports, si à certains points de vue ils sont inférieurs à quelques établissements hospitaliers anglais et américains, ils n'en ont pas moins le mérite d'avoir servi de modèles à tous les autres et d'avoir ouvert la voie du progrès dans laquelle on est entré. Nous les jugeons du reste plus sévèrement que les étrangers; nous ne nous rendons pas justice; c'est chose étrange, car il n'est pas fréquent de nous voir mécontents de nous-mêmes; c'est là notre moindre défaut. Il nous rendra service, s'il nous pousse à mieux faire.

C'est le système des pavillons séparés qui est le plus généralement adopté de nos jours. Il réunit aux qualités hygiéniques des petits hôpitaux, les avantages économiques et administratifs des grands. Il est accepté en Angleterre et en Amérique, et nous trouverons dans ces deux pays d'intéressants exemples à étudier et d'ingénieuses dispositions qu'à notre tour nous pourrions imiter; car il est remarquable que les Anglais, et surtout les Américains, soient allés plus loin que nous dans la réforme où nous les avons précédés.

Il nous a été donné de visiter plusieurs grands hôpitaux allemands. Ils présentent souvent d'heureuses dispositions intérieures qui mériteraient d'être imitées, mais en général ils sont inférieurs aux nôtres. C'est l'avis de Hammond (1),

(1) Hammond, *Hygiene with special reference to the military service*, p. 310.

c'est aussi l'avis de miss Florence Nightingale, dont l'autorité en matière d'hôpitaux est incontestable et incontestée. Ce sont, pour la plupart, de vastes constructions rectangulaires, contenant des salles adossées les unes aux autres et s'ouvrant toutes sur un large corridor. Ces salles ne reçoivent que d'un seul côté l'air extérieur et la lumière et communiquent trop facilement les unes avec les autres. Les hôpitaux allemands nous serviront surtout comme exemples à éviter.

Nous passerons successivement en revue : 1° le plan des salles de malades ; 2° leur réunion pour former un pavillon ; 3° la disposition des pavillons pour former un hôpital.

1° *Plan des salles de malades, salles communes, cabinets.* —

Il est reconnu que les salles de malades doivent présenter des dimensions supérieures à celles des salles destinées à recevoir des gens valides. Les émanations morbides et l'impérieux besoin d'un air pur et revivifiant, sont les raisons qui nécessitent, dans l'état de maladie, un cube d'air qui, de prime abord, semble exagéré. Il faut aussi que la surface accordée à chaque malade soit assez considérable ; l'expérience a prouvé qu'on ne saurait racheter la largeur et la longueur d'une salle par une hauteur même considérable, soit que les différentes couches d'air ne se mélangent pas facilement, soit que les émanations morbides s'accumulent grâce à leur pesanteur plus grande, vers les parties voisines du sol. Il ne faut donc pas espérer remplacer les unes par les autres, les trois dimensions dont dépend le cube d'air accordé à chaque malade.

Il faut se rappeler aussi que, quelle que soit la largeur avec laquelle cette première condition est remplie, il est avantageux pour les malades de ne pas se trouver réunis en trop grand nombre dans une même salle. Moins ils sont nombreux, plus il est facile de leur ménager la tranquillité et le

repos, d'exercer une surveillance suffisante et d'éviter les affections nosocomiales. C'est surtout vrai pour les salles destinées à la chirurgie et à la pratique des accouchements ; ces dernières surtout ne contiendront jamais assez peu de malades. Tarnier, dans son intéressant mémoire, demande, pour les maternités, des chambres isolées ne contenant jamais qu'une femme enceinte et une nouvelle accouchée. Pour les services ordinaires, les chiffres de 50 et de 40 lits sont trop considérables. On ne peut même en accorder 30 à 32, qu'à la condition qu'un certain nombre de lits, soit 2 ou 3, resteront toujours vides et serviront de lits de rechange ; 24 est le chiffre auquel nous nous arrêtons. Il tient le juste milieu entre le nombre trop restreint (8 à 10) que nous trouvons dans les hôpitaux de Blackburn, en Angleterre, et d'Aix-la-Chapelle, dans la Prusse rhénane, et le nombre trop considérable des lits dans certaines salles du grand hôpital de Milan (190 à 60), de l'hôpital Santo-Spirito à Rome (80 à 100), et dans quelques-uns de nos hôpitaux de Paris. Les 24 lits seront disposés sur deux rangs, correspondant chacun à une rangée de fenêtres. Toute rangée intermédiaire n'est plus suffisamment aérée ; elle nuit à la salubrité de la salle. On trouve encore trois et quatre rangées de lits dans les hôpitaux de Guy et de King's College à Londres, à la Charité de Berlin, et dans quelques-uns de nos établissements hospitaliers que l'on ne saurait trop tôt démolir.

Ceci étant posé, il est facile de déterminer, d'une façon très-précise, quelles doivent être les dimensions des salles communes destinées à la médecine ou à la chirurgie. Le lit d'hôpital a en moyenne 1 mètre de large, en mettant entre chaque lit un intervalle de 1^m,5, douze lits occuperont une longueur de 30 mètres ; ce sera la longueur de la salle. Les lits, longs de 2 mètres, distants des murs de 0^m,50 et séparés par un intervalle de 5 mètres, nous donnent comme lar-

geur de la salle 10 mètres, ce qui fait une superficie de 300 mètres carrés, soit 12^m,5 carrés par lit. En prenant comme hauteur moyenne 5 mètres, nous trouvons comme cube d'air 1500 mètres cubes, soit 62^m,5 par lit. En augmentant la longueur de la salle de 7^m,5 ou de 10 mètres, on pourrait y placer 30 ou 32 lits. Ces dimensions peuvent, au premier abord, paraître exagérées, cependant elles diffèrent peu de celles des salles de Lariboisière, et le cube d'air que nous demandons par lit, n'est ni considérable ni de beaucoup supérieur à celui qui est assuré à chaque lit dans les établissements hospitaliers nouvellement construits; c'est ce que nous montrent les chiffres suivants :

Lariboisière, cube d'air par lit :

Au rez-de-chaussée.....	58 ^m ,7
Au premier étage.....	52 ^m ,6
Au deuxième étage.....	52 ^m ,1

Royal Free Hospital à Londres, cube d'air par lit :

Moyenne..... 57^m

King's College Hospital à Londres, cube d'air par lit :

Moyenne.....	54 ^m ,8
Les nouvelles salles.....	70 ^m ,0

Dans certaines salles de Saint-Louis, le chiffre s'élève à 78 mètres cubes.

Hôpital de Blackburn, cube d'air par lit :

Moyenne..... 66^m,4

Boston Free Hospital, cube d'air par lit :

Moyenne..... 62^m,9

La moyenne des hôpitaux anglais serait, d'après Léon Lefort (voy. son mémoire, p. 30) :

Cube d'air par lit..... 52,0

Elle est jugée insuffisante.

Il est vrai que d'après MM. Blondel et Ser, cette moyenne est exagérée. Ils croient même pouvoir établir qu'elle ne s'élève pas à plus de 42^m,7. Celle des hôpitaux les moins favorisés étant 34^m,1, et celle des plus favorisés étant 57^m,2.

La moyenne que nous fournissent les hôpitaux de Paris, d'après les mêmes auteurs, est de 43^m,7.

Tenon, dès 1788, demandait au moins 51 mètres cubes par malade. C'est le chiffre adopté à tort par l'administration de l'Assistance publique de Paris pour tous ses programmes nouveaux. Nous ne voulons pas faire entendre par là qu'elle en soit restée au même point qu'avant la Révolution.

Il est évident que ce chiffre proposé par Tenon n'est pas encore suffisant. Il pouvait paraître considérable à une époque où l'encombrement était la règle dans les hôpitaux de Paris. Que si, d'un autre côté, les dimensions que nous voulons donner à nos salles d'hôpital paraissent exorbitantes eu égard au petit nombre de lits qu'elles contiennent, la dernière concession que nous consentirions à faire serait de diminuer d'un mètre leur largeur, ce qui nous donnerait comme superficie 270 mètres, soit 11^m,72 par lit, et comme capacité 1350 mètres cubes, soit 56^m,7 par lit. Les pavillons auraient alors la largeur de ceux de Lariboisière.

Cette salle type, dans les dimensions que nous proposons, peu différentes, nous le répétons, de celles qui sont généralement admises, a encore l'avantage de pouvoir se morceler facilement. Qu'on la coupe en deux suivant sa longueur par un couloir d'un mètre et demi à 2 mètres de large, bien ouvert et bien éclairé à ses deux extrémités; on peut diviser chacune de ses moitiés par des cloisons transversales, en six cabinets ayant chacun une fenêtre, 5 mètres de long et 4 mètres ou 4^m,25 de large, dimensions très-acceptables pour loger un malade et même deux au besoin.

Il serait possible aussi de réaliser l'idée ingénieuse et ori-

ginale de Tarnier, pour les salles d'accouchements : d'ouvrir tous ces cabinets au dehors, surtout si la salle est au rez-de-chaussée, et de remplacer toutes les portes qui donnent sur le couloir par des carreaux fixes au moyen desquels s'exercerait la surveillance des cabinets. L'isolement absolu des femmes nouvellement accouchées serait ainsi assuré pendant un laps de temps suffisant pour éviter l'affreuse mortalité qui les décime dans nos hôpitaux.

Nous pourrions nous occuper ici des dispositions à prendre pour assurer la salubrité des locaux dans lesquels on est forcé par la nécessité, d'installer des malades. Ce sont pour la plupart des bâtiments destinés au culte, à l'industrie ou à l'agriculture, très-peu aptes au nouveau genre de services qu'ils sont appelés à rendre. Il est souvent fort difficile d'y éviter l'encombrement; c'est à cela surtout que doivent tendre tous les efforts du médecin forcé souvent, bien malgré lui, de se plier aux dures nécessités de la guerre et des épidémies. Nous renvoyons cette étude au chapitre consacré à l'aération et à la ventilation des hôpitaux. Ce sont là les seuls auxiliaires auxquels on puisse accorder quelque confiance, bien heureux si trop souvent ils ne font pas défaut.

Il est bon de rappeler ici que l'expérience a démontré qu'au lieu d'entasser des malades dans des locaux insuffisants, mieux vaut cent fois les coucher sous la tente. Pendant la sanglante guerre d'Orient, après l'expédition de la Dobrutchka, les hôpitaux de Varna étaient encombrés de cholériques, la mortalité était effrayante. L'inspecteur médical Michel Lévy créa des hôpitaux sous la tente, prévint l'encombrement, et les plus heureux résultats furent la conséquence de cette sage mesure (1).

Pendant la dernière guerre d'Amérique, les fédéraux, en

(1) Voy. son discours sur *La salubrité des hôpitaux* (Bulletin de l'Académie, 25 mars 1862, t. XXVII, p. 593).

face de 97 751 blessés ou malades (chiffre officiel, 13 août 1864), construisirent de nombreux hôpitaux provisoires. S'il faut ajouter foi à leurs rapports, jamais l'humanité et la philanthropie, mises aux prises avec une affreuse boucherie humaine, ne firent des efforts aussi gigantesques. On vit s'élever en quelques mois sur le théâtre de la guerre 214 hôpitaux contenant 133 800 lits; et la commission sanitaire réunissait et dépensait plus de 40 millions pour aider le gouvernement à soigner ses soldats blessés.

Les salles communes de ces hôpitaux provisoires sont intéressantes à étudier; Hammond (1) nous en donne une description détaillée. C'était de longues baraques de bois parfaitement closes et bien ventilées; elles contenaient de 48 à 52 lits. Celles de l'hôpital de Point-Lookout, bâties d'après les indications de l'auteur, avaient 145 pieds de long, 25 de large, 14 de haut sur les côtés et 18 au niveau du sommet du toit qui leur servait de plafond. Elles étaient éclairées par 24 fenêtres et recevaient 52 malades qui jouissaient chacun de 70 pieds carrés et de 1116 pieds cubes.

Il est à remarquer que ces dimensions, très-insuffisantes pour les salles d'un hôpital permanent, deviennent admissibles, lorsqu'il s'agit d'une baraque de bois, soulevée à deux pieds au-dessus du sol, exposée au soleil et aux vents, et très-largement ventilée. Il y a aussi moins d'encombrement, eu égard à la superficie du sol occupé par le pavillon, que dans les hôpitaux où plusieurs étages viennent se superposer. A Lariboisière, par exemple, où dans chaque salle les malades ont chacun 11^m,25; 102 malades sont réunis dans les trois étages du pavillon sur une surface de 385 mètres carrés, soit 3^m,8 par malade, au niveau du sol.

On peut objecter à ces salles baraquées, de contenir un nombre de malades trop considérable, aussi ont-elles été visitées par la pourriture d'hôpital et l'infection purulente,

(1) *Loc. cit.*, p. 327.

On peut désirer mieux ; mais la guerre a ses tristes nécessités et ceux qui se rappellent nos ambulances de Crimée et nos hôpitaux de Constantinople, ne se montreront pas exigeants. Du reste, aujourd'hui même, en temps de paix et dans nos grandes villes, la plupart de nos malades sont dans de plus fâcheuses conditions.

2° Pavillons d'hôpital, nombre d'étages occupés par des malades. — Lorsque plusieurs salles sont superposées, les supérieures sont les moins salubres, et celles que soient la puissance et la perfection des appareils de ventilation, la mortalité y est plus grande que dans les salles inférieures. C'est un fait reconnu aujourd'hui, démontré par la statistique et par l'observation ; on ne saurait discuter que l'explication qui en a été donnée : les miasmes humains ou substances volatiles délétères que développe toute agglomération d'hommes et surtout de malades, montent en suivant les courants d'air chauds qui s'établissent de bas en haut dans les bâtiments habités. Il faut donc éviter dans la construction d'un pavillon qui doit être occupé uniquement par des salles de malades, d'élever plusieurs étages les uns au-dessus des autres.

On se contente aujourd'hui de superposer deux salles de malades, et afin d'éviter à celles qui occupent le rez-de-chaussée, l'humidité et le froid du sol, on les soulève à quelques pieds de terre au moyen d'un sous-sol ou de caves voûtées où l'air peut circuler librement. Le général Morin, qui, par ses travaux, a rendu de nombreux services à l'hygiène hospitalière, a fait remarquer qu'il n'est pas nécessaire de donner au sous-sol une hauteur considérable, celui des poudrières n'a pas un mètre de haut.

Les salles du rez-de-chaussée sont très-avantageuses pour les malades, surtout pour les convalescents qui peuvent les quitter et y rentrer sans fatigue, lorsqu'ils désirent faire au dehors leurs premiers pas chancelants. Qui n'a rencontré

quelque malheureux, assis sur les marches d'un escalier d'hôpital, et reposant sur ce siège incommode ses membres qui fléchissent sous lui ? Qui n'a vu tomber les amputés sur ces marches trop souvent glissantes, polies, inhospitalières ? C'est au rez-de-chaussée que l'on doit de préférence mettre les services de chirurgie. Rappelons ici que c'est au rez-de-chaussée que Tarnier veut placer les chambres isolées qu'il destine aux nouvelles accouchées.

Beaucoup d'hôpitaux construits dans ces derniers temps n'ont pas de second étage. Les pavillons de l'hôpital de Boston sont formés d'un sous-sol, d'un rez-de-chaussée et d'un premier étage. Il en est de même pour l'hôpital de Woolwich qui doit être terminé aujourd'hui, pour l'hôpital militaire de Malté, pour l'hôpital Saint-Louis à Paris.

Nous trouvons un étage et une seule rangée de salles à l'hôpital des Cliniques, deux étages et deux rangées de salles à la Charité, à Cochin et à la maison d'accouchements. Tous les autres hôpitaux de Paris, sauf les nouveaux pavillons du Val-de-Grâce où nous ne trouvons que le rez-de-chaussée et le premier étage occupés par des malades, ont trois et quatre rangées de salles superposées.

Cette règle qui devrait être respectée dans la grande majorité des cas, est peut-être sujette à quelques exceptions ; ainsi dans les hôpitaux militaires, où l'on reçoit indistinctement blessés, fiévreux et vénériens, il n'y aurait peut-être pas très-grand inconvénient à construire un second étage et une troisième rangée de salles, pour y loger les malades de la troisième catégorie, atteints pour la plupart d'accidents légers et capables de descendre dans les cours et dans les préaux pendant la plus grande partie de la journée. On pourrait aussi, dans les hôpitaux militaires où il y a des dépôts d'infirmiers, employer le second étage comme casernement. C'est là une question d'économie administrative sur laquelle nous ne croyons pas devoir nous prononcer d'une façon formelle. Mieux vaudrait certainement loger

infirmiers et vénériens dans des bâtiments séparés : ce sont des hôtes turbulents.

Il conviendrait, peut-être, de faire la même exception pour la plupart des hôpitaux de province qui sont en même temps des hospices. Ici le même inconvénient ne serait plus à craindre, et le second étage pourrait former une troisième rangée de salles pour les infirmes et les vieillards ; on les loge bien souvent plus haut. De même aussi, dans certains petits hôpitaux, ne comportant qu'un seul pavillon, le second étage pourrait servir de magasins, le rez-de-chaussée et le premier étage étant occupés par les malades et l'administration ayant un bâtiment indépendant. Ou bien même, tout se trouvant réuni sous le même toit, au premier étage serait la salle des malades, au second et au rez-de-chaussée les bureaux et les dépendances.

En résumé, la seule règle à poser est celle-ci : il ne faut pas superposer plus de deux rangées de salles occupées par des malades. Le pavillon d'hôpital doit donc se composer, outre le sous-sol ou les caves, d'un rez-de-chaussée et d'un premier étage.

3° *Dispositions des pavillons, plans qui ont été suivis ou proposés pour la construction des hôpitaux formés de pavillons séparés.* — Les pavillons ne devant contenir que 50 malades environ, les dispositions à prendre seront très-différentes, suivant que l'hôpital est destiné à recevoir moins de 50 lits, 100 lits, ou que prenant des proportions plus considérables, il est appelé à comporter plus de deux pavillons. Les quelques lignes que nous venons de consacrer aux petits hôpitaux, ne comportant qu'une ou deux salles de malades, nous semblent suffisantes. Grâce au petit nombre de malades qu'ils contiennent, ils jouissent d'une salubrité qui ne laisse d'habitude rien à désirer.

Pour 100 lits environ, nous avons quatre salles de malades et deux pavillons composés d'un soubassement, d'un

rez-de-chaussée et d'un premier étage. On les disposera sur une même ligne, séparés par un bâtiment destiné à l'administration et aux dépendances.

Il sera presque toujours possible de choisir pour ces petits hôpitaux une orientation favorable et de les entourer de jardins, en évitant le voisinage trop immédiat des arbres de haute futaie. Leur peu d'importance les privera du secours de la vapeur et des puissants appareils de chauffage et de ventilation, mais ce défaut sera compensé par le petit nombre de malades qu'ils contiennent.

Nous ne croyons pas qu'il y ait aucune objection sérieuse à faire à l'exécution d'un pareil plan. Il serait à désirer que l'on puisse assez morceler le service hospitalier des grandes villes pour ne jamais dépasser ces dimensions restreintes ; malheureusement les administrateurs trouvent la chose impossible et préfèrent construire de grands hôpitaux.

Voyons quelles ont été les dispositions adoptées jusqu'ici pour grouper, dans un grand hôpital, les pavillons destinés aux malades près des bâtiments consacrés aux services administratifs. Les éléments du problème à résoudre sont les suivants : isoler les pavillons assez pour qu'ils ne puissent se nuire, ni dans leur ventilation, ni dans leur aération ; assurer entre eux une communication facile à l'abri des intempéries en les rapprochant et en les reliant les uns aux autres. Parcourons rapidement le plan de quelques-uns des hôpitaux les plus importants.

La disposition la plus simple est celle dans laquelle les pavillons sont parallèles et réunis entre eux et aux bâtiments administratifs par une galerie rectiligne. Ils sont disposés sur un rang dans l'hôpital de Brest, dans celui de Vincennes, dans l'hôpital militaire de Malte, dans l'Episcopal Hospital de Philadelphie ; sur deux rangs, à droite et à gauche du couloir : à l'hôpital militaire de Woolvick, au Judiciary square Hospital de Washington, à l'hôpital de Blackburn, etc. ; enfin, les pavillons forment deux rangées

perpendiculaires à deux couloirs parallèles à Lariboisière et à West-Philadelphia Hospital. Nous trouverons ensuite quelques plans plus compliqués, où les galeries sont courbes et où les pavillons qu'elles relient sont dirigés parallèlement à des rayons partant d'un même point.

Hôpital de Brest. — L'hôpital de la marine, à Brest, est de construction récente : commencé en 1823, il fut terminé en 1832, sous le ministère de M. Clermont-Tonnerre, dont il porte le nom. Il est formé de dix pavillons parallèles, séparés par un intervalle de 15 mètres, et mis en communication par une galerie couverte. Les pavillons ne sont pas tous identiques : les huit plus grands sont réunis deux par deux à l'extrémité opposée à la galerie commune, aussi leur isolement n'est pas aussi parfait que l'on pourrait le désirer (fig. 1) (1). L'hôpital de Brest s'éloigne donc d'une façon assez sensible des hôpitaux construits d'après le système des pavillons séparés ; il est destiné à contenir 1179 malades, soit plus de 100 lits par pavillon, chiffre évidemment trop considérable, si l'on considère leur peu d'étendue et l'étroit intervalle qui les sépare. M. Husson lui reproche aussi d'être étroitement enfermé par des bâtiments dépendant de l'arsenal maritime ; c'est là une condition défavorable à la ventilation et à l'aération.

Hôpital militaire de Vincennes. — C'est le plus parfait de tous les hôpitaux qui relèvent de l'administration de la guerre. De construction toute récente, il n'a été ouvert aux malades qu'en 1858. Il est formé de deux grands pavillons doubles et rectangulaires, séparés par un intervalle de 150 mètres environ, et réunis entre eux et au bâtiment de l'administration par une large galerie ouverte qui aboutit à la cage d'escalier pratiquée au centre de chacun des pavillons. Ceux-ci se trouvent donc divisés vers leur milieu, et il est

(1) Quelques-unes des figures qui accompagnent cet article ont été empruntées à l'*Étude sur les hôpitaux*, de M. Husson.

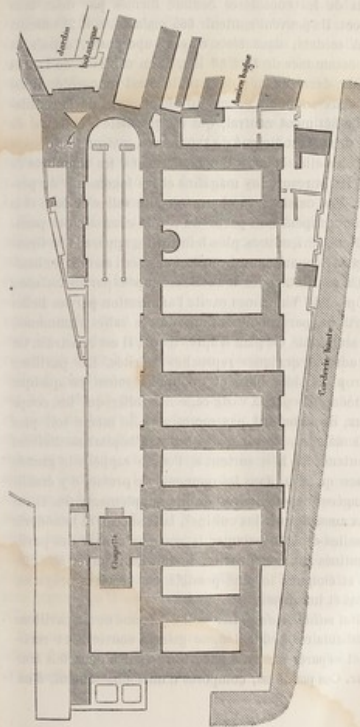


Fig. 1. — Hôpital Clermont-Tonnerre, à Brest.

permis de les considérer comme formés par deux ailes séparées. Ils peuvent contenir 665 malades, soit 21 officiers et 644 soldats, dans trois étages superposés, divisés en salles communes de 32 à 40 lits, et en cabinets de 1, 2 et 4 lits. Le dernier étage des pavillons est mansardé; il est défectueux au point de vue du chauffage et de la ventilation. Le bâtiment central, qui est parallèle à la route de Paris, dont il est éloigné de 120 mètres environ, est occupé par la chapelle, la salle des conférences, les chambres de garde, les bureaux, les magasins et les logements du personnel. Les cuisines, la pharmacie, les salles de bain et la lingerie occupent une partie du rez-de-chaussée des pavillons. Nous reviendrons plus loin sur les appareils de Grouvelle et de Regnault, au moyen desquels sont assurés le chauffage et la ventilation des deux ailes occupées par les malades.

L'hôpital de Vincennes excite l'admiration par ses belles proportions, par les dimensions de ses salles communes, par la simplicité du plan d'après lequel il est construit. On lui a adressé quelques reproches mérités. Les pavillons sont trop considérables, et quoiqu'ils soient en quelque sorte dédoublés par la vaste cage d'escalier qui les coupe en deux, ils n'abritent pas moins sous le même toit plus de 300 malades. De plus, des salles d'hôpital ne doivent pas contenir 40 lits, surtout si l'on se rappelle la grande tendance qu'on a, dans les moments de presse, d'y établir des rangées intermédiaires de lits supplémentaires. Il est fâcheux aussi de voir les cuisines, la tisanerie, la buanderie et les salles de bain occuper le rez-de-chaussée des pavillons destinés aux malades : on devrait les réserver à la chirurgie et éloigner le plus possible ces services bruyants, odorants et humides.

Hôpital militaire de Malte. — Il est formé de six pavillons perpendiculaires à une longue galerie couverte et rectiligne, et séparés par un espace libre égal à deux fois leur hauteur. Ces pavillons, composés d'un soubassement, d'un

rez-de-chaussée et d'un premier étage, construits dans un bastion de forme irrégulière, n'ont pas tous la même longueur; les plus grands ne comportent que deux salles superposées de 32 lits chacune. A chaque salle se trouvent annexées, du côté de la galerie, une chambre d'infirmier et une office, et du côté opposé une salle de bains et des latrines. Le bâtiment destiné à tous les services administratifs est parallèle à la galerie; il en est séparé par deux petites cours rectangulaires; trois couloirs convergents partant de la galerie y aboutissent. Cet hôpital de Malte, qui n'est guère destiné à plus de 300 malades, nous semble un modèle à suivre.

Episcopal Hospital de Philadelphie. — Il diffère peu du précédent; nous empruntons sa description à Hammond. Il se compose d'un bâtiment central contenant la chapelle, l'amphithéâtre chirurgical, etc., d'où partent de chaque côté un corridor couvert et une veranda, sur lesquels tombent à angle droit quatre pavillons séparés destinés aux malades. Ceux-ci comportent deux salles superposées et un attique destiné à certains cas spéciaux qui ne sont pas indiqués par l'auteur. Les salles contiennent 30 lits : elles ont 30 pieds 10 pouces de large, 120 pieds de long et 16 pieds de haut; il y a donc par lit 120 pieds de surface et 2000 pieds cubes, ce qui équivaut à environ 70 mètres cubes par malade, chiffre supérieur à celui dont nous nous sommes contentés. Le sous-sol des pavillons contient les cuisines et les magasins, qui sont réunis par des couloirs souterrains. Enfin, d'après le plan que nous avons sous les yeux, les pavillons semblent distants les uns des autres d'environ 20 à 25 mètres. Ce bel hôpital, bâti sur une si large échelle, ne contient que 325 lits. Hammond s'écrit avec orgueil qu'il est supérieur aux plus beaux hôpitaux d'Europe; il pourrait bien avoir raison.

Voyons maintenant quelques-uns des hôpitaux où les pavillons forment une double rangée et sont disposés à droite et à gauche d'une galerie rectiligne qui les réunit.

été adopté, les pavillons, au nombre de douze et largement espacés, sont disposés par paires des deux côtés d'une longue galerie aux extrémités de laquelle s'élèvent deux bâtiments rectangulaires destinés, l'un au service des aliénés, l'autre à l'amphithéâtre de chirurgie et aux cabinets des opérés. Les pavillons ont deux étages formant, pour les huit plus grands, deux salles communes de 28 à 32 lits. Les bâtiments destinés aux services administratifs sont parallèles à la galerie de communication; ils sont séparés des pavillons par un espace libre d'une étendue suffisante. Ce vaste établissement, si conforme aux principes modernes de l'hygiène hospitalière, contiendra, comme Vincennes, 650 malades.

Judiciary Square Hospital de Washington. — Cet hôpital, construit sur un plan presque identique avec les précédents, est un de ces nombreux hôpitaux provisoires qui abritèrent les milliers de blessés de la dernière guerre américaine. Quoique ces vastes établissements, appelés à ne durer tout au plus qu'une dizaine d'années, soient formés par des pavillons bâtis en bois, recouverts d'un enduit de stuc, soulevés à deux pieds du sol et sans étages supérieurs, nous ne croyons pas inutile de rappeler en quelques mots les judicieuses dispositions qu'ils présentent. Rien ne saurait empêcher, du reste, de les imiter en maçonnerie, et leur étude permettra peut-être à l'intelligente administration des hôpitaux militaires d'éviter à l'avenir les désastres hospitaliers de Crimée et de Constantinople. Le Judiciary Square Hospital, un des premiers construits par la commission sanitaire des États-Unis, a quelque ressemblance, dans la disposition de ses dix pavillons, avec l'hôpital de Blackburn. Ils partent, à angle droit, d'un long et large couloir rectiligne, à l'extrémité duquel s'élèvent les bâtiments destinés aux services administratifs. Les pavillons de droite rencontrent le couloir en face des espaces

vides qui séparent les pavillons de gauche. Tous identiques entre eux, abondamment fournis d'eau, éclairés au gaz, chauffés par trois foyers ouverts et bien ventilés par des ouvertures pratiquées au niveau du toit qui les recouvre, et dans le plancher, sous les lits, ils sont appelés à contenir chacun 25 malades, ce qui fait 250 malades pour tout l'hôpital. Hammond, à qui nous empruntons cette description, recommande, dans la construction de ces pavillons, de les espacer largement et de mettre les latrines et les salles de bains annexées à chacun d'eux le plus loin possible de la galerie de communication. Un autre hôpital provisoire fut construit sur le même plan, par les soins de la commission sanitaire, à Mount-Pleasant, hors de l'enceinte de Washington. Ce sont là des établissements d'une bien faible importance, comparativement à ceux dont nous nous occuperons plus loin.

Deux galeries parallèles, réunies vers leur milieu ou à leurs extrémités par les bâtiments de l'administration, font communiquer les pavillons entre eux dans l'hôpital Lariboisière et dans le West Philadelphia Hospital.

Hôpital Lariboisière. — « Édifié au nord de Paris, dans l'ancien clos Saint-Lazare, l'hôpital Lariboisière, dit M. Husson, est, de tous nos hôpitaux, celui qui sous divers rapports répond le plus complètement à sa destination. »

« La construction de cet établissement a été entreprise en 1846, d'après les plans de M. Gauthier, membre de l'Institut. Le programme remis par l'administration à cet architecte lui recommandait de s'inspirer des idées émises en 1788 par les commissaires de l'Académie des sciences et par Tenon, sur la construction des hôpitaux. Aussi le projet exécuté reproduit-il dans son ensemble le plan général publié dans les *Mémoires de l'Académie*. » Ainsi,

quoique de construction récente, puisqu'il n'a été ouvert aux malades qu'en mars 1854, l'hôpital Lariboisière remonte comme conception et comme plan général à une époque antérieure à la révolution française. Il est contemporain de Tenon. Si nous nous reportons à une date aussi reculée, nous avons tout droit d'être fiers de ce bel hôpital, malgré les attaques nombreuses et souvent méritées auxquelles il a été en but dans ces derniers temps. Lariboisière a beau être appelé le *Versailles de la misère*, on a beau lui reprocher son insalubrité, ses statistiques défavorables et comme médecine et comme chirurgie, il n'en est pas moins vrai que c'est un des premiers pas faits vers la perfection, dans la construction des hôpitaux, et l'on est forcé d'admirer l'étendue des connaissances sur l'hygiène hospitalière que possédaient des hommes qui n'avaient eu sous les yeux que les nombreux défauts de l'ancien Hôtel-Dieu. Il faut donc reconnaître à cet hôpital les mérites incontestables qu'il a, et il peut très-bien se passer de l'apologie à outrance de ceux qui veulent en faire la réunion de toutes les perfections.

Il a aussi des défauts que nous chercherons à signaler; nous nous contenterons d'étudier le plan de l'hôpital et les quelques objections que l'on est en droit de lui adresser. Dans d'autres parties de notre essai, nous nous occuperons de la ventilation, du chauffage et de l'ameublement des salles et des mille questions de détail qui ont dans les hôpitaux une importance si grande et pour lesquelles il nous servira souvent de point de comparaison.

« L'hôpital Lariboisière (fig. 3) se compose d'une série de bâtiments à deux étages chacun, séparés entre eux par des préaux ou promenoirs et établis sur deux lignes parallèles.

« Une grande cour plantée occupe le centre des bâtiments.

« Une galerie vitrée règne sur les quatre côtés de cette

« cour, établit une communication à couvert entre tous les

« services et peut servir de promenoir pour les convalescents. »

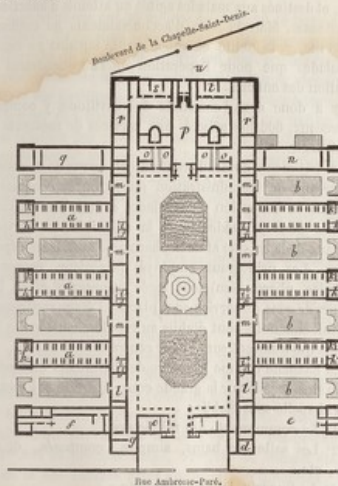


Fig. 3. — Hôpital Lariboisière. Plan du rez-de-chaussée, échelle de 1 demi-millimètre pour 1 mètre. a, salle des malades; b, préaux des malades; c, bureaux de la direction; d, consultations externes; e, réfectoire des gens de service, cuisine générale et ses dépendances; f, pharmacie; cabinet de pharmacie, dépendances de la pharmacie; g, vestiaire des médecins; h, malades agiles; i, cabinet de la sœur; j, église; k, dépôt de linge sale et lieux d'aisances des malades; l, bibliothèque; m, réfectoire des malades; n, communauté; o, bains; p, chapelle; q, blancherie et dépendances; r, salle d'opérations; s, salle des morts et d'autopsie; t, vestiaire; u, cour des cours.

Les pavillons affectés aux malades sont au nombre de 6, dont 3 pavillons à droite et 3 à gauche.

« Chaque pavillon contient trois salles de 32 lits, plus 2 lits installés dans une petite chambre, au bout de chacune des salles, et destinés aux malades agités ou atteints d'affections contagieuses. Mais la salle d'accouchements ne contient que 28 lits, et la petite chambre qui la termine ne reçoit de malades que pour l'opération de l'accouchement et l'ablution des enfants. »

Il y a donc dans l'ensemble des pavillons, y compris 28 berceaux, 606 lits affectés aux services de médecine et de chirurgie.

« Les bâtiments de façade renferment, au rez-de-chaussée, les bureaux de l'administration (direction et économe), les salles de réception des malades et des consultations externes pour la médecine et la chirurgie, les services généraux de la cuisine et de la pharmacie avec leurs dépendances. Les principaux employés (directeur, économe, aumônier, pharmacien) sont logés au premier étage. Des dortoirs de gens de service sont placés à l'étage supérieur.

« Huit chauffoirs sont établis au rez-de-chaussée des bâtiments qui s'élèvent sur la cour centrale.

« La chapelle occupe le centre des bâtiments du fond et forme ainsi façade sur la grande cour. A droite et à gauche de la chapelle sont établis :

« 1° La communauté des religieuses ;
« 2° Les salles de bains, simples, composés, de vapeur, etc. ;

« 3° La lingerie, la buanderie, etc. ;

« 4° Le dortoir des filles de service.

« Deux amphithéâtres pour les leçons et cours et pour les opérations existent à droite et à gauche de la chapelle.

« L'amphithéâtre pour les autopsies, la salle de repos, ainsi que divers magasins et hangars, séparés par des cours de service, sont placés en arrière de la chapelle.

« Les pavillons de malades comprennent huit services médicaux, savoir :

« Six services de médecine, y compris un service d'accouchement,

« Et deux services de chirurgie. »

Les pavillons ont 45 mètres de long, 10 de large et 18 de hauteur. Ils ne sont séparés les uns des autres que par un intervalle de 20 mètres, chiffre qui nous semble trop faible pour permettre une bonne insolation et une aération suffisante des pavillons, car ils se trouvent, grâce à leur rapprochement et à leur hauteur, couverts les uns par les autres. Le bénéfice des pavillons isolés se trouve ainsi en grande partie perdu, le vent et la lumière n'ayant pas un accès facile sur les façades des bâtiments ; l'air corrompu des salles peut plus facilement pénétrer dans les pavillons voisins. Il est vrai que la ventilation artificielle obvie en partie à cet inconvénient, surtout pendant l'hiver, mais cet air vicié, refoulé hors des salles par les ventilateurs, ne pouvant pas être suffisamment balayé par les courants atmosphériques, crée autour des pavillons une véritable atmosphère hospitalière. Il faudrait donc un intervalle plus considérable entre les pavillons.

Les bâtiments occupés par les malades ont trois étages de salles superposées. Nous nous sommes déjà plusieurs fois expliqué à ce sujet : c'est un étage de trop.

Les salles sont très-grandes, les lits sont espacés, et le cube d'air par lit est de 58^m,701 au rez-de-chaussée, 52^m,685 au premier étage, 52^m,417 au second étage. Ce sont là des chiffres assez élevés et peu différents de ceux que nous avons indiqués nous-même ; mais le nombre des malades par salle est de trente-deux, ce qui est un chiffre assez élevé si l'on n'a pas soin de toujours conserver quelques lits vacants, et loin de là, on propose d'ajouter, dans les salles, des lits supplémentaires. Ce reproche ne saurait être exagéré, surtout lorsqu'il s'agit de la salle d'accouchements. On n'a pas le droit de mettre dans une même

salle, quelque grande qu'elle soit, vingt-huit lits destinés à être occupés par un service d'accouchements.

Nous reviendrons plus loin sur les systèmes de chauffage et de ventilation employés à Lariboisière. Qu'il nous suffise de rappeler encore le chiffre élevé des dépenses premières qui n'est pas inférieur à 10445156 francs! Réparti entre 606 lits, il nous donne, en moyenne, par lit 17236 fr. 21 c. Devant de pareilles sommes, il semble évident qu'aucun plan d'hôpital ne doit être trop dispendieux pour l'administration des hôpitaux de Paris; et, en effet, d'après le rapport du professeur Tardieu (1), le nouvel Hôtel-Dieu doit coûter 21 400 000 francs (chiffre d'estimation qui est toujours dépassé); et comme il ne doit contenir que 716 lits, nous trouvons que la dépense s'élèvera par lit à plus de 29888 francs! Ce sont là des chiffres qui sont de nature à exciter l'exigence des chirurgiens, qui doivent tranquilliser beaucoup les architectes et les faiseurs de devis, et qui, bien certainement, leur rendent la besogne facile.

West Philadelphia Hospital. — C'est un de ces établissements provisoires considérables, créé par les nécessités de la guerre. Il est situé, comme son nom l'indique, à l'ouest de Philadelphie, sur un emplacement d'une salubrité irréprochable. Le plan suivant lequel il a été construit rappelle celui de Lariboisière; il y a, toutefois, entre ces deux établissements la différence à laquelle il faut s'attendre, si l'on compare de vastes bâtiments à plusieurs étages construits en maçonnerie, avec des pavillons baraqués, appelés seulement à une durée éphémère.

Deux corridors, qui ont 860 pieds de long, 14 pieds de large et 13 pieds de haut, séparés par un intervalle de 75 pieds, sont réunis vers leur milieu par des bâtiments réservés à tous les services administratifs.

Sur chacun des corridors tombent à angle droit 17 pa-

(1) *Annales d'hygiène*, juillet 1865.

villons, qui ont 167 pieds de long, 24 pieds de large et 19 pieds de haut, jusqu'au sommet du toit, disposés de façon à assurer la ventilation. L'espace entre les pavillons n'a que 21 pieds.

Chaque pavillon contient: 1° au centre, une salle commune de 147 pieds de long, percée de trente fenêtres; 2° du côté du corridor, deux cabinets pour l'infirmier en chef et pour la sœur de charité; et 3° du côté opposé, deux petites salles séparées du service par un couloir: ce sont les latrines et la salle de bain.

Les salles de malades de chaque pavillon contiennent 48 lits; leur surface est égale à 3428 pieds carrés, soit plus de 71 pieds carrés par lit; leur capacité est de 54 848 pieds cubes, soit de 1141 pieds cubes par lit. Il y a vingt-quatre fenêtres, soit deux lits par fenêtre.

Partout on trouve en abondance l'eau froide et l'eau chaude; cette dernière est fournie par une machine à vapeur. Les eaux ménagères et les immondices sont recueillis par deux tubes de terre cuite, placés à quelques pieds sous terre parallèlement aux corridors; leur diamètre est de 10 pouces. Ils passent sous les latrines de tous les pavillons, reçoivent l'eau des salles de bains, et se réunissent dans un tuyau de 12 pouces, qui aboutit à la rivière, Mill Creek, après s'être débarrassé des parties solides qu'il charrie dans un drain suffisamment éloigné de l'hôpital.

Nous trouvons dans le même établissement, bien séparés des salles de malades, des cuisines, des buanderies, des réfectoires, des logements pour les médecins et les administrateurs, des réservoirs d'eau considérables, une machine à vapeur, une imprimerie, une chapelle, etc., etc.

Il serait facile de critiquer le West Philadelphia Hospital, mais il faut tenir compte des difficultés exceptionnelles contre lesquelles avaient à lutter ceux qui étaient chargés de la construction et de la direction de ces établissements. On pourrait demander d'espacer plus les pavillons et de les

faire moins longs et plus larges; mais il fallait abriter plus de 3000 malades, et cette impérieuse nécessité nous explique comment cet hôpital, destiné d'abord à 1344 malades, a plus que doublé après les campagnes meurtrières de l'été et de l'automne de 1862. Au moment où écrivait Hammond, le West Philadelphia Hospital contenait 3124 lits; nous verrons plus loin que le Mower general Hospital était encore plus considérable.

Dans tous les hôpitaux que nous venons de parcourir, les pavillons tombent à angle droit sur des galeries rectilignes au moyen desquelles ils communiquent entre eux et avec les bâtiments administratifs; dans ceux qu'il nous reste à étudier, la disposition des pavillons n'affecte plus la même simplicité, ils sont groupés d'une façon très-variable et souvent ingénieuse autour des bâtiments destinés aux services administratifs.

Hôpital Saint-Louis de Gonzague, à Turin (fig. 4). — C'est un des plus curieux exemples que nous puissions prendre. Quatre pavillons partent, en divergeant comme les branches d'un X, d'un bâtiment central à peu près circulaire où se trouvent la chapelle, le vestibule, la salle des consultations, les cages d'escalier, etc. Ces quatre pavillons, occupés par les malades, sont réunis deux à deux par des bâtiments qui joignent leurs extrémités. Il en résulte, entre deux ailes du même côté, deux cours triangulaires fermées de tous côtés, ce qui est une condition fâcheuse pour la ventilation de l'hôpital.

Les salles occupées par les malades présentent une disposition assez curieuse, que nous retrouvons à l'hôpital de Saint-Mandrié, à Toulon. Au lieu de s'ouvrir directement au dehors par des croisées, elles sont entourées par un large couloir que l'air et la lumière doivent traverser pour arriver jusqu'à elles, et derrière chaque lit se trouve une petite porte de service, donnant sur le couloir, par laquelle les cadavres ou même les lits peuvent être enlevés sans

troubler la tranquillité de la salle. Comme les quatre pavillons s'ouvrent sur la chapelle qui est centrale, au moyen de larges portes que l'on ouvre pendant les cérémonies religieuses, du milieu de la chapelle on peut voir tout l'hôpital.

MM. Gaultier de Claubry (1), Husson (2), Hammond (3), et M. Antony Rouillet, décrivent ce curieux hôpital et l'apprécient de façons très-diverses. Parmi ses qualités, nous

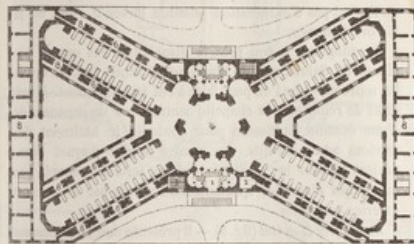


Fig. 4. — Hôpital et œuvre de Saint-Louis de Gonzague à Turin. Plan du premier étage. — 1, vestibule; 2, chambre pour la récréation des malades; 3, escalier principal; 4, église; 5, infirmerie; 6, passage derrière les lits; 7, dépendances; 8, latrines.

trouvons qu'il n'y a qu'une salle commune de 24 lits par pavillon, que cette salle formant un rez-de-chaussée, élevé sur un soubassement, les malades convalescents peuvent la quitter pour se promener et y remonter sans fatigue. Mais le couloir qui entoure les salles est défavorable à leur aération; c'est une disposition fâcheuse que ne compense pas la facilité qu'elle donne pour le service des salles. Les deux

(1) H. Gaultier de Claubry, *Hôpital Saint-Louis à Turin* (*Annales d'hygiène*, 1859, 2^e série, t. XII, p. 118).

(2) *Op. cit.*, p. 471.

(3) *Treatise on hygiene with special reference to the military service*, Philadelphia, 1863, p. 339.

ailes transversales qui réunissent les branches de l'X nous semblent aussi préjudiciables à la salubrité de l'hôpital; nous en avons déjà dit la raison. Quant à la chapelle centrale, malgré les six foyers ouverts, disposés comme moyen de ventilation dans les six pilastres qui soutiennent son dôme, n'est-il pas à craindre qu'elle n'établisse une trop facile communication entre les quatre salles de malades? A ceux qui nous trouveraient exagérés, nous répondrons qu'il n'est pas d'exagération possible lorsqu'il s'agit de la vie des hommes.

En adoptant à peu près la disposition des quatre pavillons de Saint-Louis de Gonzague, il serait facile d'éviter les reproches que l'on peut faire à cet établissement. Il suffirait de remplacer la chapelle centrale par un espace vide d'une étendue suffisante pour contenir le bâtiment des services administratifs, aux quatre angles duquel viendraient aboutir les pavillons qui en seraient séparés par des cages d'escalier spacieuses ou même par de courtes galeries couvertes.

Boston free Hospital (fig. 5). — Il présente une très-curieuse disposition des six pavillons dont il est formé. Nous trouvons, au centre, un grand bâtiment carré destiné à tous les services administratifs. Du milieu de trois de ses côtés partent, à angle droit, trois galeries couvertes qui se doublent et donnent naissance à six galeries circulaires formant un quart de cercle et allant en divergeant. A l'extrémité de chacune d'elles s'élève un pavillon. Ces six pavillons sont disposés par paires: quatre d'entre eux sont parallèles à la façade du bâtiment carré, deux se trouvent à sa droite et deux à sa gauche. Ils sont plus grands que les deux derniers, situés sur les derrières, et perpendiculaires aux premiers. S'irradiant ainsi deux par deux d'un point central, ils s'éloignent les uns des autres et du bâtiment administratif. L'espace qui sépare les pavillons entre eux a 100 pieds de large.

Les quatre grands pavillons ont 117 pieds de long et 28 pieds de large; ils se composent d'un sous-sol et de deux étages occupés par deux salles de 25 malades. Les deux plus petits ont 89 pieds de long, 28 pieds de large, et ne contiennent que 25 lits.

Les salles des grands pavillons ont 400 pieds de long,

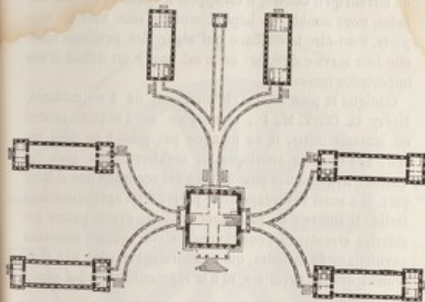


Fig. 5. — Boston free Hospital. Plan du rez-de-chaussée.

28 pieds de large, ce qui fait, pour chaque lit, plus de 100 pieds carrés et 1600 pieds cubes; elles sont percées de 18 fenêtres. A chacune d'elles sont annexés deux cabinets de service, des latrines et une salle de bains.

Dans les petits pavillons réservés aux malades qui ont le plus besoin d'air et d'espace, les salles sont plus petites et les lits plus espacés. On y trouve aussi des cabinets pour les malades atteints d'affections contagieuses.

Le Boston free Hospital est remarquable sous bien des rapports: les salles sont spacieuses et ne contiennent qu'un nombre très-limité de malades; elles n'occupent que deux étages, le sous-sol étant réservé au service des pavillons.

Ceux-ci sont très-largement espacés, et une distance suffisante les sépare du bâtiment central; ils ne contiennent que 50 lits et sont reliés entre eux par de grandes galeries dans lesquelles les malades se promènent lorsque le temps est mauvais; ce sont là des conditions excellentes de salubrité, et cet établissement qui, malgré la grande étendue de terrain qu'il couvre, n'est appelé à contenir que 250 malades, nous semble un hôpital modèle sous tous les rapports. Peut-être la distance qui sépare les pavillons rend-elle leur service difficile: ce n'est pas là un défaut d'une importance majeure.

Quoique le plan de cet hôpital soit dû à un médecin, Henry G. Clark, M. D., chirurgien de l'hôpital général de Massachusetts, il ne manque pas plus, à ce qu'il paraît, des qualités artistiques et architecturales que des qualités hygiéniques auxquelles a été accordée une si large part. Il a aussi l'avantage de se prêter à un agrandissement facile. Il suffirait de prolonger en ligne droite quatre des galeries circulaires pour pouvoir élever quatre nouveaux pavillons de 50 malades, qui ne nuiraient en rien, ni à l'isolement des six premiers, ni à la régularité et au bel aspect de l'hôpital.

En 1786, Poyet fut chargé de faire le plan d'un nouvel hôpital destiné à remplacer l'Hôtel-Dieu, qu'on voulait démolir et déplacer. Il présenta un projet qui, malgré ses défauts, est resté justement célèbre, et quoiqu'il n'ait pas été suivi d'exécution, il mérite de nous arrêter un moment. On y retrouve le germe de toutes les idées adoptées de nos jours pour la construction des hôpitaux. Ce plan, modifié suivant les circonstances, a été suivi par les Américains dans leurs plus beaux hôpitaux provisoires, et plus d'un architecte y puisera encore d'utiles enseignements.

Poyet proposait de bâtir dans l'île des Cygnes, devant le Champ de Mars, un hôpital circulaire destiné à 5000 malades et construit de manière que toutes les salles fussent

parfaitement isolées. Le plan qu'il présentait était d'une grande simplicité (fig. 6).

Deux galeries circulaires et concentriques enveloppent dans un double cercle l'emplacement occupé par l'hôpital;

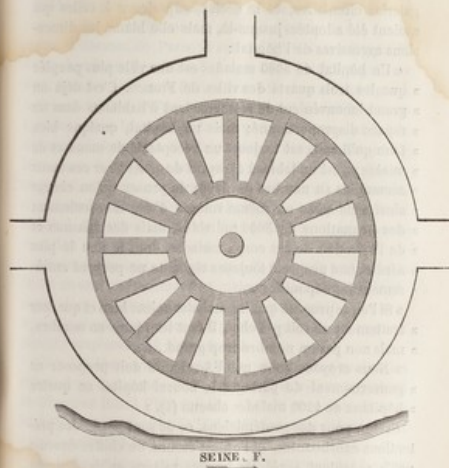


Fig. 6. — Plan d'hôpital, présenté par Poyet.

au centre, une grande cour au milieu de laquelle s'élève un bâtiment; entre les deux galeries, allant de l'une à l'autre en divergeant comme des rayons, les pavillons, au nombre de seize, occupés par les malades. Le plan de Poyet res-

semble à une roue dont les rayons sont des pavillons d'hôpital.

La commission de l'Académie des sciences chargée de critiquer les différents projets qui lui étaient soumis approuva la disposition des salles qui se terminent aux deux galeries circulaires, et la déclara supérieure à celles qui avaient été adoptées jusque-là, mais elle blâma les dimensions excessives de l'hôpital :

« Un hôpital de 5000 malades est une ville plus peuplée que les trois quarts des villes de France. C'est déjà un grand inconvénient de resserrer tant d'habitants dans un espace disproportionné; mais un hôpital, quelque bien tenu qu'il soit, est toujours un réceptacle de maux et de misère; c'est un tableau effrayant de considérer ces maux accumulés au nombre de 5000; de penser qu'on charge ainsi sans cesse un même volume d'air, non-seulement des émanations de 5000 individus, mais des miasmes et de l'infection de ces corps malades, dont le lieu le plus aéré et une propreté toujours vigilante ne peuvent entièrement les dépouiller..... »

« Si l'on se propose que les malades soient bien et que leur traitement ne soit pas cher, il faut les réunir en nombre, mais non pas en nombre trop grand..... »

« Nous croyons donc que l'Académie doit proposer au gouvernement de partager le nouvel hôpital en quatre hôpitaux de 1200 malades chacun (1). »

Certes, pour des académiciens, ce ne sont pas là des prétentions exorbitantes, et l'on est étonné du chiffre énorme qu'ils acceptent après les bonnes raisons qu'ils donnent contre le plan de Poyet, et après les dangers qu'ils décrivent comme conséquences inévitables des agglomérations considérables de malades.

Il y a bien aussi d'autres objections à faire contre le plan

(1) Rapport du 22 novembre 1786, p. 98.

de Poyet. L'hôpital contenant 5000 malades dans seize pavillons, chaque pavillon abrite sous son toit plus de 375 malades. Ce ne sont plus là des pavillons séparés, mais des hôpitaux séparés; car un établissement qui contient 375 malades peut bien être considéré comme un grand hôpital.

L'idée de choisir une île pour y bâtir un hôpital n'est pas non plus des plus heureuses, surtout si cette île est sur la Seine en dessous de Paris. Il est vrai qu'il s'assurait par là d'une abondante provision d'eau; mais, à cette époque surtout, tous les égouts de Paris se rendaient en droite ligne à la Seine, et l'eau de l'île des Cygnes devait laisser beaucoup à désirer sous le rapport de sa pureté. On comprend, à la rigueur, que lorsqu'un hôpital est établi dans une île, on l'y laisse, car, à ce qu'il paraît, c'est très-difficile à déplacer; nous voulons bien le croire, la preuve en est palpable; mais, ce qui semble plus difficile à admettre, c'est qu'une île de la Seine devienne jamais un lieu d'élection pour la construction d'un nouvel hôpital.

Il est donc de toute évidence que Poyet avait tort dans le choix de son emplacement, et malgré l'esprit lucide et ingénieux dont il faisait preuve dans le plan qu'il proposait, il montrait une ignorance complète des conditions que doit réunir l'emplacement d'un hôpital.

L'hôpital *Mower*, ainsi appelé du nom du plus ancien des chirurgiens de l'armée du Nord, fut construit sur le plateau de Chestnut Hill, à Philadelphie. C'est le plus vaste de tous les hôpitaux provisoires de la dernière guerre d'Amérique; il contenait 3320 lits.

Un vaste bâtiment en forme de croix, occupé par les bureaux, les cuisines, les magasins, la machine à vapeur, le logement des employés, etc., est entouré d'une cour de la forme d'un rectangle dont les angles sont arrondis.

Cette cour a 653 pieds de long et 522 pieds de large; elle est limitée par une galerie couverte, large de 16 pieds et

longue de 2500, fermée sur les côtés par des panneaux vitrés mobiles, et chauffée en hiver par 50 fourneaux.

A cette galerie, irrégulièrement circulaire, viennent aboutir 50 pavillons baraqués qui ont 175 pieds de long, 20 pieds de large, 19 pieds de haut; ils vont en divergeant suivant la direction des rayons partant du centre de la cour. Vers leur extrémité voisine de la galerie ils sont distants les uns des autres de 20 pieds; à l'extrémité opposée 40 pieds les séparent.

Les pavillons de l'hôpital Mower sont semblables à ceux du West Philadelphia Hospital, ventilés, chauffés et éclairés de la même façon; ils sont occupés par 52 lits et possèdent chacun un réfectoire, une office, des latrines et une salle de bains.

Ils sont abondamment fournis d'eau chaude et d'eau froide par la machine à vapeur. Le système de drainage est le même dans ces deux hôpitaux, et grâce à la quantité d'eau considérable fournie par la machine, les tubes sont continuellement parcourus par un rapide courant.

Un système de sonneries électriques permet au médecin en chef de correspondre de son bureau avec tous les services.

Un petit chemin de fer établi dans la galerie de communication permet de transporter les aliments des cuisines dans les services, sur de petits chariots chauffés à l'eau chaude. On peut, en cas de besoin, s'en servir pour transporter les malades.

Nous pourrions faire à l'hôpital Mower les mêmes reproches qu'à West Philadelphia Hospital; c'est un établissement trop considérable, les salles sont trop étroites; elles sont trop longues et contiennent trop de malades.

Nous ne nous arrêtons pas à décrire l'hôpital Mac-Clellan de Philadelphie; il ne diffère du précédent que par la forme plus écrasée de sa cour ellipsoïde, ce qui a forcé à placer en dehors une partie des bâtiments destinés aux services administratifs.

Si nous parcourons encore quelques-uns de ces établissements, qui n'ont pas eu en Europe tout le retentissement qu'ils méritent, nous trouvons d'abord le *Hammond Hospital*. Etabli sur les bords de la mer, au point où le Potomac va se jeter dans la baie de Chesapeake, il diffère moins que tous les autres du plan général proposé par Poyet (fig. 7).

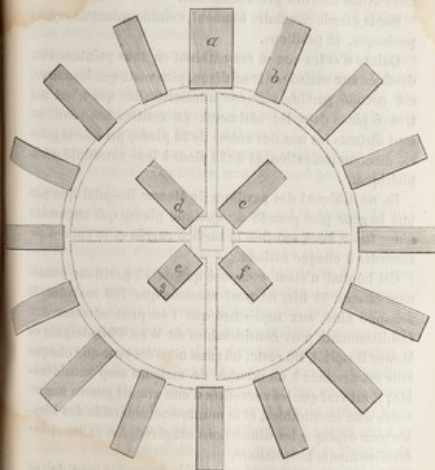


Fig. 7. — Hammond General Hospital. Plan du rez-de-chaussée : a, bureaux de la direction; b, salles de malades; c, cuisine; d, lingerie; e, maison de garde; f, infirmerie; g, chambre des morts.

La cour est un cercle parfait de 318 pieds de diamètre, au centre duquel s'élèvent, disposés en croix grecque, quatre bâtiments occupés par la cuisine, la buanderie, le maga-

sin d'habillement, et le corps de garde réuni à la salle des morts.

Une galerie circulaire enveloppe la cour, qui est coupée en quatre par quatre galeries droites aboutissant au centre, entre les ailes de la croix grecque. Ces galeries ont les mêmes dimensions et la même disposition que celles que nous avons décrites précédemment.

Sur la galerie circulaire tombent, comme autant de rayons prolongés, 16 pavillons.

Quinze d'entre eux se ressemblent en tous points et sont destinés aux malades; le seizième, plus vaste que les autres, est occupé par les services administratifs qui n'ont pas trouvé place dans les bâtiments du centre. Les pavillons sont distants les uns des autres de 36 pieds, près de la galerie de communication, et de 75 pieds à leur extrémité périphérique.

Ils ne diffèrent des pavillons de Mower Hospital que par une largeur plus grande de quelque pieds, qui augmente d'une façon assez sensible la surface carrée et le cube d'air accordés à chaque malade.

Cet hôpital n'étant composé que de 15 pavillons contenant chacun 52 lits, ne peut recevoir que 780 malades. Il échappe ainsi aux reproches que l'on peut adresser aux établissements plus considérables de West Philadelphie et Mower Hospital. Du reste, ici aussi nous croyons que chaque salle est destinée à un nombre de malades trop considérable; il est vrai que les nécessités d'une grande guerre meurtrière sont inexorables, et le nombre considérable des blessés nous explique les dimensions exagérées des salles et des établissements hospitaliers.

Pour montrer l'enseignement que l'on peut tirer de ces hôpitaux temporaires, qu'il nous suffise de présenter ici quelques chiffres applicables à un hôpital permanent formé par des pavillons ayant un sous-sol, deux étages de salles, et pouvant contenir chacun 48 à 50 malades.

En suivant à peu près la dimension du terrain et la disposition des pavillons de l'hôpital de Point Lookout, nous arrivons à loger 480 à 500 malades de la façon suivante.

Les pavillons simples que nous avons décrits comme types, au commencement de cet article, ont 10 mètres de large et 35 mètres de long, dont 30 pour la salle, plus 5 mètres pour un cabinet et l'escalier, soit 35 mètres. Formés d'un sous-sol et de deux étages, ils reçoivent 48 malades dans deux salles superposées.

En rangeant 10 de ces pavillons, à 20 mètres de distance les uns des autres, autour d'une galerie circulaire de 300 mètres, on obtient une cour ronde ayant 100 mètres de diamètre. Ce sont là à peu près les dimensions du cercle intérieur aux pavillons de Point Lookout.

Au centre de la cour, un bâtiment, relié par des galeries droites à la galerie circulaire, serait occupé par les services administratifs.

Le cercle extérieur aux pavillons a 170 mètres de diamètre, c'est la longueur du diamètre de la cour, plus deux fois la longueur d'un pavillon; son rayon est de 85 mètres, sa surface est égale à $85 \times 85 \times 3,141 = 22,725$ mètres carrés. Ce chiffre est très-curieux, et quoique nous ne cherchions pas à accorder à notre ébauche plus de valeur qu'elle ne mérite, nous ne pouvons pas ne pas faire remarquer que c'est presque exactement l'emplacement que doit occuper le nouvel Hôtel-Dieu (1). Il est vrai que le nouvel Hôtel-Dieu doit recevoir 716 malades au lieu de 500, chiffre auquel nous arrivons. Est-ce une qualité ou est-ce un défaut? Nous ne nous permettrons pas de critiquer un projet qui a su mériter l'approbation du brillant doyen de la Faculté de Paris, mais l'éloquent défenseur lui-même, malgré l'assurance que lui donne sa haute position scientifique, a beaucoup de peine à défendre l'insuffisance de la superficie

(1) Voy. le mémoire de Tardieu dans les *Annales d'hyg.*, juillet 1865.

accordée à un nombre si considérable de malades, et il reconnaît que ces deux chiffres, mis en face l'un de l'autre, sont de nature à éveiller quelques craintes. Espérons que l'avenir ne viendra pas les réaliser.

Pour le moment, qu'il nous suffise d'établir que sur un emplacement de 22 000 mètres de superficie et en suivant le plan de Poyet, modifié par Hammond, on peut loger 500 malades dans dix pavillons largement espacés, chacun des pavillons ne contenant que deux salles de 25 malades, avec 12^m,5 de superficie, et 62^m,5 de cube d'air par lit.

Enfin, comme dernier type, nous avons encore l'hôpital *Lincoln*, de Washington city. Comme disposition des pavillons il est très-différent de tous ceux que nous avons étudiés jusqu'ici, et il est remarquable par son extrême simplicité.

Deux longues galeries couvertes forment en se rencontrant un angle de 45 degrés environ, 21 pavillons parallèles à la bisectrice de l'angle tombent sur ces deux galeries et communiquent avec elles au moyen de corridors très-courts, qui se détachent de la galerie et qui sont perpendiculaires aux pavillons. Les pavillons sont donc parallèles entre eux et disposés en échelons.

Dans l'angle compris entre les deux galeries sont disposés en forme de croix cinq bâtiments séparés, destinés à tous les services administratifs.

Cette disposition en échelons présente des avantages et des inconvénients qui sautent aux yeux.

Les pavillons, situés à peu près à égale distance des services administratifs, auront tous la même orientation. C'est un avantage que ne partagent pas les hôpitaux où les pavillons vont en s'irradiant d'un point commun. De plus, tous les bâtiments ayant la même direction (et il va sans dire que l'on choisira la plus favorable), d'un autre côté, l'angle formé par les deux galeries étant largement ouvert, l'aé-

tion des pavillons sera assurée et les vents régnants pourront facilement balayer tout l'emplacement occupé par l'hôpital, condition très-favorable à sa salubrité.

Les inconvénients de la disposition en échelons sont faciles à prévoir : plus l'angle formé par les deux galeries sera aigu, plus les pavillons qui sont parallèles se rapprocheront, et pour conserver entre eux une distance suffisante, il faudra les espacer sur la galerie de communication, qui atteindra alors une longueur trop considérable : tout dépendra donc du degré d'ouverture de l'angle formé par les galeries. De plus, l'extrémité des pavillons vers laquelle se trouvent les latrines et les salles de bains se trouvent en face des croisées des pavillons supérieurs. Enfin, il nous a semblé, en examinant le plan de l'hôpital *Lincoln*, qu'une grande étendue de terrain se trouve perdue et qu'à surface égale la disposition en échelons ne permet pas d'élever autant de pavillons que les dispositions précédentes.

Il serait peut-être curieux de voir comment les architectes de l'administration de Paris ont mis à profit tous ces documents si divers, dans le plan approuvé aujourd'hui du nouvel Hôtel-Dieu. Mais nous ne voulons pas revenir sur un sujet qui a déjà été traité avec une habileté extrême par le professeur Tardieu (1). Du reste, les objections que nous pourrions faire, quelque justes et quelque fondées qu'elles soient, ne seraient probablement écoutées de personne. Il est vrai que nous ne serions pas les seuls à ne pas être écoutés, car on ne pourrait se trouver en plus brillante et en plus savante compagnie.

IV. — Aération et ventilation naturelle des hôpitaux.

Une bonne aération et une ventilation naturelle facile, sont deux conditions indispensables aux bâtiments hospi-

(1) *Annales d'hygiène publique*, juillet 1865.

taliers : la ventilation artificielle, quelque puissante et active qu'elle soit, ne pourra jamais les remplacer et ne peut être considérée que comme leur auxiliaire utile.

L'aération et la ventilation des salles d'hôpital dépendent en grande partie du plan d'après lequel ont été construits les bâtiments qu'elles occupent. C'est pour que les salles de malades soient exposées de tous les côtés à l'air et à la lumière qu'on les a placées de nos jours dans des pavillons séparés, largement espacés. La disposition des bâtiments en croix, comme à l'*Hospice des incurables (femmes)*, la forme carrée qui a prévalu à *Saint-Louis* et à la *Charité*, les fers à cheval que l'on rencontre à *Saint-Antoine*, à *Cochin*, à *Guy's Hospital*, à l'*Hôpital des enfants*, les cours carrées entourées de tous côtés par des salles de malades, comme à l'*Hôpital majeur de Milan* et dans la plupart des *hôpitaux militaires construits par Vauban*, telles sont les principales formes suivies jusqu'ici, toutes défavorables à la ventilation et à l'aération des salles de malades.

Il ne nous serait pas difficile, en feuilletant le savant ouvrage de Husson, de trouver encore de nombreux exemples à éviter parmi les hôpitaux de construction ancienne.

Aération et ventilation naturelle ne sont pas absolument synonymes, quoique elles soient dépendantes l'une de l'autre et qu'on les réalise en même temps. Sous le nom d'aération nous comprenons surtout l'action de l'air et de la lumière, et tout le monde sait que la ventilation est due à des courants atmosphériques qui balayent en quelque sorte mécaniquement les surfaces sur lesquelles ils passent.

Il faut que les salles d'hôpital soient enveloppées dans une atmosphère pure et libre, obéissant facilement aux courants d'air naturels. Il faut que la lumière solaire y trouve un accès facile. Cette dernière condition est une des plus indispensables à la salubrité des salles. La lumière est nécessaire à tout ce qui est doué de vie; les végétaux comme

les animaux, pris dans l'état de santé, ne tardent pas à dépérir lorsqu'ils en sont privés, à plus forte raison s'ils sont malades. Il est à remarquer que cette privation n'a pas besoin d'être absolue pour agir d'une façon manifeste : la végétation est rabougrie et misérable à l'ombre des grands arbres, et cependant la clarté y semble suffisante. Il faut que les salles d'hôpital reçoivent des flots de lumière solaire; les inconvénients qui pourraient en résulter ne sont pas à comparer aux avantages réels que les malades en retirent; c'est un excitant naturel qui réveille leur organisation défaillante et active leur convalescence; c'est un excitant inoffensif qui réjouit le cœur et relève le moral abattu. Le soleil, c'est la vie; la nuit, c'est la mort; la lumière, c'est la santé et la force.

Et que l'on ne craigne pas de pécher par excès en ouvrant à la lumière des accès faciles et nombreux. Il suffit de se rappeler que, dans les pays où les rayons solaires ont la plus grande intensité lumineuse, la nuit ne le cède pas au jour comme durée, et permet au malade un repos prolongé; que, du reste, les malades s'habituent vite à dormir en pleine lumière, et qu'il est toujours facile, au moyen de quelques rideaux, d'en modérer suffisamment l'intensité. En hiver et dans les pays froids, la lumière ne sera jamais un inconvénient. En été et dans les pays chauds, il devient difficile, il est vrai, si ce n'est impossible, de séparer les rayons lumineux des rayons calorifiques; mais qui ne sait la facilité avec laquelle la plupart des malades supportent la chaleur? qui ne se rappelle les brillants succès de la chirurgie de Larrey sous le soleil brûlant d'Égypte, alors que ses blessés étaient couchés sous la tente, et les statistiques si favorables des opérations en été et dans les pays chauds comparativement à ce qu'on observe en hiver et dans les pays froids? — La chaleur ne saurait donc être considérée comme une condition fa-

cheuse; et pour la prévenir, même lorsqu'elle est très-élevée, on n'est jamais en droit de diminuer la somme de lumière indispensable aux malades. Parmi les modernes, J. B. Martin (1) est un de ceux qui ont le mieux fait ressortir l'importance d'un libre accès de la lumière solaire dans les salles d'hôpital. Il s'appuie sur l'autorité de Priestley et sur les expériences de Edwards; d'après lui, le pire de tous les défauts que peuvent présenter les services hospitaliers, c'est l'obscurité, car il est parfaitement impossible d'y remédier par des moyens artificiels.

Peut-être un jour nous sera-t-il permis d'analyser l'action de la lumière solaire sur la vie. Qu'il nous suffise, pour le moment, de constater son influence; les connaissances physiques et chimiques actuelles ne nous permettraient que des hypothèses. On a décomposé les rayons solaires; on leur a reconnu des qualités physiques et chimiques nombreuses et variées; un jour on ira plus loin, et on saura pourquoi ils sont indispensables à la vie.

La ventilation a pour but de renouveler l'air des salles et d'en purifier continuellement l'atmosphère. La ventilation naturelle se fait par les fenêtres, par les portes et par toutes les ouvertures qui s'ouvrent au dehors; elle n'a pour agents que les vents régnants et les courants que déterminent les différences de température entre l'air extérieur et l'air contenu dans les salles. Il serait facile de nous étendre longuement sur l'importance de la ventilation en général: c'est une vérité qui, de nos jours, ne souffre plus discussion; elle a été établie par l'observation de tous et par les travaux de nombreux savants dont l'autorité est incontestable. Il est démontré actuellement que l'air est vicié très-rapidement par la respiration et par les exhalations organiques, surtout lorsqu'elles proviennent d'individus malades. —

(1) Holmes, *System of surgery by various authors*, t. IV, p. 909.

Ainsi altéré, l'air acquiert des qualités délétères dont l'action pernicieuse est des plus manifestes. — La quantité d'air nécessaire aux malades ne saurait être calculée d'après la quantité d'oxygène nécessaire à la respiration; elle est beaucoup plus considérable. — L'acide carbonique exhalé par les poumons n'est pas la seule cause d'insalubrité de l'atmosphère des salles encombrées; les exhalations organiques, pulmonaires et cutanées semblent même des agents morbifiques plus énergiques. C'est sous leur influence que se développent les affections endémiques si fréquentes dans les salles d'hôpital. — Peut-être des corps microscopiques tenus en suspension dans l'air ou mêlés à la poussière des salles (globules de pus, cellules épithéliales, microzoaires, etc.) doivent-ils être considérés comme des agents habituels d'infection.

Toutes les questions ayant trait à la ventilation ont été le sujet de recherches et d'études sérieuses. Nous ne pourrions, sans sortir des limites restreintes de cet article, analyser le mémoire de Leblanc (1), celui de Ramon de Luna (2). Nous avons aussi étudié avec fruit les *Discours* du baron Larrey (3), de Michel Lévy (4), le *Mémoire* de Cazalas (5), celui de Jacquot (6), de Baudens (7); et enfin les rapports et les notes de lord Panmure et de miss Nightingale sur le même sujet, le mémoire de Lassaigue (8), et, en 1852, un mémoire de Boudin (9).

(1) *Annales de chimie et de physique*, 1832, t. V, p. 260.

(2) *Annales d'hygiène*, 1861, t. XV, p. 361.

(3) *Hôpitaux militaires* (*Bulletin de l'Académie de médecine*, 1862).

(4) *Salubrité des hôpitaux en temps de paix et en temps de guerre* (*Bulletin de l'Académie de médecine*, 1862).

(5) *Maladies de l'armée d'Orient*, campagne de 1854-56. Paris, 1860.

(6) *Des typhus de l'armée d'Orient*, Paris, 1858.

(7) Baudens, *La guerre de Crimée*. Paris, 1858.

(8) *Annales d'hygiène*, 1846, t. XXVI, p. 297.

(9) *Sur la circulation de l'eau comme moyen de chauffage et de ventilation* (*Annales d'hygiène*, 1852).

La ventilation naturelle a pour agents les portes et les fenêtres, qui, lorsqu'elles sont ouvertes, permettent à des courants d'air de traverser les salles en différents sens et d'en renouveler l'atmosphère : ce sont les seuls moyens de ventilation auxquels on ait recours dans les maisons particulières. Il faudrait y ajouter les cheminées et les foyers ouverts, qui agissent activement pendant la saison froide; mais la ventilation qui leur est due est artificielle, et nous l'étudierons lorsque nous nous occuperons des appareils au moyen desquels on obtient le chauffage et la ventilation réunis.

On ne se fait que très-difficilement une idée de la quantité d'air qui parcourt une salle dans un temps donné, lorsque les fenêtres sont largement ouvertes. Cette quantité est hors de toute proportion avec celle que l'on obtient par les appareils de ventilation les plus puissants. Supposons, en effet, un courant d'air qui fasse seulement 6 mètres à la minute; il est à peine sensible, et c'est tout au plus s'il fait vaciller la flamme d'une bougie. Si ce courant est produit par deux fenêtres opposées largement ouvertes, ayant 1^m,5 de large et 4 mètres de haut, le cube d'air qu'il introduit par minute dans la salle est égal à $1^m,5 \times 4 \times 6 = 360$ mètres cubes. En une heure, il est égal à $1^m,5 \times 4 \times 6 \times 60 = 21,600$. Dans une de nos salles de pavillon comportant 24 lits, avec 6 fenêtres de chaque côté, la quantité d'air qui traverserait la salle en une heure, toutes les fenêtres étant ouvertes, serait $21\,600 \times 6 = 129\,600$ mètres cubes, soit, par heure et par malade, 5400 mètres cubes. Si nous opposons ce chiffre à celui que l'on obtient par les appareils de chauffage et de ventilation les plus puissants, on est étonné de la différence : 100 mètres cubes par heure et par malade. Si nous poussons plus loin la comparaison, nous trouvons, en maintenant ce chiffre de 100 mètres

cubes, qui n'est presque jamais atteint (1); nous trouvons que 24 malades reçoivent en une heure 2400 mètres cubes à Lariboisière, à Necker, à Vincennes, etc. C'est à peu près dix fois moins que la quantité de 21 600 fournie par une seule fenêtre, et il est bon de remarquer que le chiffre de 6 mètres par minute est excessivement faible. Pour peu que le vent soit sensible, il se trouve dépassé de beaucoup. Le courant d'air qui ouvre ou ferme avec une certaine violence nos portes et nos fenêtres entr'ouvertes fait plusieurs mètres à la seconde; il nous fournit, par le calcul basé sur des expériences anémométriques sérieuses, des chiffres considérables et hors de toute proportion avec ceux que l'on obtient par la ventilation artificielle.

Nous ne craignons pas d'insister sur cette partie de notre étude; nous lui accordons la plus grande importance. Confiant dans les moyens de ventilation artificielle, éblouis par les chiffres 60, 80 et même 100 mètres cubes qui se présentaient seuls, chirurgiens et médecins ont négligé la ventilation naturelle, et l'on peut dire hardiment que les hôpitaux les moins bien ventilés sont ceux où l'administration a dépensé pour la ventilation des sommes considérables; car, nous le répétons, la quantité d'air fournie par ces dispendieuses machines est minime et ne saurait à elle seule suffire pour assainir une salle d'hôpital. Lors de la dernière discussion qui a eu lieu à la Société de chirurgie sur l'hygiène hospitalière, le professeur Gosselin, dans un discours plein de modération, a fait ressortir l'importance de la ventilation naturelle et les heureux résultats que l'on peut obtenir, même dans un hôpital défectueux sous tous les rapports, par les simples moyens auxquels nous avons recours dans nos habitations particulières.

(1) Voyez à ce sujet le livre de Husson et celui du chef de bataillon du génie Benoit, *Mémoires de l'officier du génie*, n° 17, p. 203.

Le Rapport de MM. Blondel et Ser sur les hôpitaux de Londres est très-intéressant à étudier au point de vue de la ventilation naturelle des salles de malades. Ils ont été surtout frappés de trouver partout les fenêtres et les portes largement ouvertes; souvent ils étaient incommodés par des courants d'air. Ils reviennent presque à chaque page sur cette remarque, et ne cherchent pas à dissimuler un certain étonnement. On se demande même, au début du mémoire, s'ils ne vont pas ranger les courants d'air parmi les nombreux défauts des hôpitaux anglais; ils finissent toutefois par reconnaître que cette ventilation naturelle, quoique exagérée, pourrait bien présenter pour les malades de sérieux avantages.

Si la ventilation naturelle est appelée à rendre de si grands services, ne présente-t-elle pas quelques inconvénients? Nous ne les croyons pas de nature à la faire négliger, surtout pour les services de chirurgie.

On peut craindre, en ouvrant largement les fenêtres, de trop refroidir les salles en hiver et d'exposer les malades à des courants d'air. On a beaucoup médité des courants d'air; on les accuse de tous les maux dont la cause réelle échappe à l'observation: c'est là de l'étiologie comme sait en faire le vulgaire profane; l'homme de l'art ne doit pas partager la même crédulité. Par eux-mêmes, les courants d'air ne sont pas bien à craindre; ce n'est pas eux bien certainement qui augmentent la mortalité dans nos salles d'hôpital. Peut-être serons-nous en droit de leur attribuer quelques rhumes légers, quelques douleurs rhumatoïdes; peu importe, s'ils doivent diminuer la fréquence des purritures d'hôpital, des infections purulentes, des infections putrides, des érysipèles et des fièvres puerpérales. Je travaille presque toute l'année dans un courant d'air, et je n'ai jamais eu à m'en plaindre.

L'inconvénient le plus sérieux de la ventilation naturelle,

c'est l'abaissement rapide de la température dans les salles aussi largement ouvertes. Ce n'est qu'en hiver et pendant les plus grands froids que cet abaissement de température peut avoir quelque fâcheux effet pour les malades; lorsqu'il n'est pas considérable, il est sans inconvénient; bien plus, il ne manque pas de médecins, surtout à l'étranger, qui considèrent ces légères variations de température comme favorables à la santé des malades. Nous ne serions pas très-éloigné de partager leur opinion, quoique nous ne puissions pas nous expliquer comment elles agissent; peut-être leur action est-elle stimulante: le froid, par la réaction qu'il provoque, active les fonctions organiques, lorsqu'il n'est ni excessif, ni trop prolongé.

Du reste, il est bon de se rappeler que les malades, couchés et bien couverts, sont protégés contre les variations de température, et, si ce n'est dans les pays froids, le nombre des jours où la libre entrée de l'air extérieur leur serait préjudiciable est excessivement restreint. D'un autre côté, pendant les grands froids, on est forcé de faire beaucoup de feu dans les salles, et c'est, comme nous le verrons, un bon moyen de ventilation. La ventilation artificielle se présente alors comme utile auxiliaire de la ventilation naturelle.

Voyons maintenant quels seront le nombre, les dimensions et la disposition des fenêtres dans une salle de malades. Il faut qu'il y ait une fenêtre pour deux lits de malades; une salle de vingt-quatre lits sera donc percée de douze fenêtres, six de chaque côté de la salle. Elles seront disposées symétriquement l'une en face de l'autre. C'est dans l'intervalle des fenêtres que seront placés les lits, deux par deux, la tête dirigée vers le mur et les pieds vers l'axe de la salle. Les deux lits qui correspondent au même trumeau seront plus rapprochés l'un de l'autre que des lits voisins, afin de conserver libre l'accès des fenêtres.

Les fenêtres doivent monter jusqu'au plafond, car c'est vers la partie supérieure que s'accumule l'atmosphère échauffée des salles, et si ce n'est au moyen de la ventilation artificielle (voyez plus loin : *Ventilation renversée, appel en contre-haut et en contre-bas*), l'air n'est que très-imparfaitement renouvelé par les courants qui s'établissent dans les zones inférieures. — Les fenêtres doivent descendre assez bas, et nous serions presque tenté de les abaisser jusqu'au niveau du plancher. En tous cas, la hauteur à laquelle elles s'arrêtent ne doit pas dépasser 0^m,50. Pendant longtemps et dans beaucoup d'hôpitaux, les fenêtres des salles de malades étaient à 6 pieds du sol. Cette élévation avait pour but d'empêcher les courants d'air de s'établir au niveau des lits occupés par les malades; inutile et fâcheuse précaution. Les couches d'air les plus inférieures ont, elles aussi, besoin d'une ventilation active, et l'ascension des colonnes d'air réchauffées par les malades n'est pas suffisante pour les renouveler. Il doit s'établir, du reste, dans les coins, sous les lits, dans l'angle formé par le plancher et la muraille, des points morts où ne s'établit aucun mouvement et où l'atmosphère est stagnante. Il est donc important, au point de vue de la ventilation naturelle, que les fenêtres descendent assez bas, pour qu'en les ouvrant on obtienne des courants d'air jusqu'au niveau du plancher.

Il est encore deux raisons qui nous portent à assurer aux fenêtres une hauteur aussi grande : d'abord les salles seront mieux éclairées, et nous avons vu quelle importance il faut accorder à la lumière solaire; puis elles prendront un aspect plus gai et plus animé; elles cesseront de ressembler à des salles de prison.

Rien n'est triste comme ces longues salles d'hôpital, où les fenêtres sont élevées au-dessus de la hauteur de l'homme : le malade, comme le prisonnier qui ne peut

voir que le ciel et son cachot, se sent séparé du monde et ne repose sa vue que sur les misères qui l'entourent. Miss Nightingale nous raconte qu'un malheureux blessé, épuisé par de longues souffrances, se faisait soulever mourant jusqu'à la hauteur de l'appui d'une fenêtre, et pleurait de plaisir à la vue du monde qu'il allait quitter. Cette noble femme comprenait bien tout ce que renfermaient de tristesse et de désespoir les larmes du pauvre blessé.

Il est inhumain de priver de la vue du dehors des hommes appelés à faire dans une salle d'hôpital un séjour prolongé; cette vue seule leur permet d'oublier un moment leur misère et les fait espérer. Il y a quelques mois, nous visitâmes le nouvel hôpital d'Aix-la-Chapelle; splendidement installé hors l'enceinte de la ville, dans un endroit charmant, il est entouré de grands jardins bien plantés. Nous sommes entré dans des salles peintes en couleurs sombres, et par les fenêtres, à 6 pieds du sol, comme par le soupirail d'un cachot, on ne voyait qu'un coin du ciel. Dans ce bel édifice, où rien n'a été ménagé, les salles sont tristes et désolées.

Nous donnerons donc aux fenêtres, dans les salles qui ont 5 mètres de haut, une hauteur moyenne de 4^m,50, et nous les diviserons en deux ou trois compartiments.

Le compartiment supérieur sera fermé par un châssis vitré, mobile autour d'un axe horizontal. C'est une disposition qui est en Angleterre d'un usage fréquent, et dont Tardieu réclame l'application pour le nouvel Hôtel-Dieu. On règle, au moyen d'une tringle en fer ou d'une corde passant dans une poulie, le degré d'inclinaison du châssis, qu'un contre-poids tend continuellement à fermer. Le châssis s'ouvrant obliquement et ne s'abaissant pas jusqu'à l'horizontale, dirige les courants d'air vers le haut de la salle et protège très-suffisamment les malades contre leur action directe. Il est utile que le châssis supérieur soit in-

dépendant, pour qu'à un moment donné on puisse l'ouvrir seul.

Les deux compartiments inférieurs de la fenêtre peuvent être fermés par des châssis semblables à celui du haut; nous n'y voyons aucun inconvénient; ou bien on peut les réunir et y mettre des croisées à espagnolettes semblables à celles que l'on emploie dans nos habitations particulières. Peut-être vaudrait-il mieux conserver un compartiment inférieur, haut d'un mètre environ et indépendant, fermé par un châssis mobile autour d'un axe horizontal passant vers son milieu, et réserver les croisées à espagnolettes pour le compartiment moyen. Nous n'attachons pas grande importance à la disposition des châssis dans la partie inférieure de la fenêtre; pourvu que l'on puisse l'ouvrir largement et la fermer hermétiquement, tous les systèmes sont bons.

Les portes prennent, elles aussi, une part assez active à la ventilation, mais leur rôle n'est que tout à fait accessoire. Il est nécessaire qu'il y en ait deux, une à chaque extrémité de la salle. La porte d'entrée, qui communique avec l'escalier et le cabinet de surveillance, doit être à deux battants, assez large pour qu'un brancard y passe facilement; on doit pouvoir la tenir ouverte. La porte opposée s'ouvre dans un étroit couloir dirigé perpendiculairement à l'axe de la salle et communiquant avec le water-closet; c'est une porte simple, maintenue fermée par un des nombreux systèmes usités de nos jours; elle doit rester absolument étrangère à la ventilation.

Parcourons maintenant rapidement les différents systèmes de ventilation artificielle.

V. — Ventilation artificielle des hôpitaux.

Les systèmes de ventilation artificielle sont nombreux et différent les uns des autres d'une façon notable. Les uns

sont d'une très-grande simplicité et n'ont pour agent que le calorique qui se développe dans les salles mêmes occupées par les malades; ils se rapprochent sensiblement de la ventilation naturelle. D'autres sont plus compliqués et plus dispendieux; ils nécessitent des machines et des dispositions spéciales; ils sont d'introduction récente dans les hôpitaux. Prenons quelques exemples; le plus simple de tous est le suivant :

Des ouvertures sont pratiquées au plancher de la salle ou vers la partie inférieure de la muraille et communiquent au dehors par des conduits directs qui traversent le mur; des ouvertures semblables sont faites au plafond ou vers la partie supérieure de la muraille. L'air extérieur pénètre dans la salle par les bouches inférieures, s'y échauffe, et, devenant plus léger, monte vers les points les plus élevés et s'échappe par les bouches supérieures. Ce système a été le seul employé dans les pavillons baraqués des hôpitaux temporaires d'Amérique et, au dire de Hammond, il a été suivi des plus heureux résultats. Mais la ventilation ainsi obtenue est malheureusement très-irrégulière : on comprend facilement qu'elle sera d'autant plus active que la différence sera plus grande entre la température de la salle et la température extérieure. En hiver on devait y renoncer, car elle donnait naissance à des courants d'air froid très-énergiques, et le chauffage des salles ne pouvait plus suffire à contre-balancer la perte rapide du calorique.

Un système peu différent du précédent, et qui donne en hiver d'assez bons résultats, consiste à conduire par des tuyaux l'air venant du dehors dans une gaine qui enveloppe le poêle. Cet air s'échauffe rapidement au contact du poêle, pénètre dans la salle par des bouches dites de chaleur, pratiquées sur la gaine enveloppante, monte, grâce à son excès de température, vers les parties supérieures, redescend en suivant le plafond le long des murailles au contact

desquelles il se refroidit un peu, et se disperse dans toute la salle. Grâce à l'excès de pression produit par son entrée incessante, l'air s'échappe, soit par les joints des portes et des fenêtres, soit par des bouches de sortie pratiquées dans le plancher et dans la muraille. Ce système, employé dans les nouveaux pavillons du Val-de-Grâce, est bon comme moyen de chauffage, mais laisse à désirer comme ventilation. De plus, sous l'influence du vent, surtout lorsqu'il y a des bouches de sortie, le tirage peut s'établir en sens inverse. Enfin, lorsqu'on ne fait pas de feu, le calorique développé par les malades étant le seul agent d'appel, le tirage est très-insuffisant et la ventilation devient à peu près nulle.

Transportons le poêle dans le sous-sol et conduisons sa gaine et ses bouches de chaleur à travers les planchers et les murailles jusque dans les salles, nous aurons, comme nous le verrons plus loin, le point de départ de calorifères compliqués, au moyen desquels s'obtiennent le chauffage et la ventilation réunis. Avant de les étudier, parcourons encore quelques-uns des systèmes les plus simples.

L'appareil du docteur Arnott (fig. 8) est une bouche d'extraction ouverte près du plafond dans la languette des cheminées. Cette ouverture est fermée par une plaque métallique percée de trous et par un voile d'étoffe légère flottant vers l'intérieur de la cheminée. Cette valvule mobile est destinée à s'appliquer sur la plaque métallique, si, le courant sous l'influence du vent, l'air et la fumée contenus dans

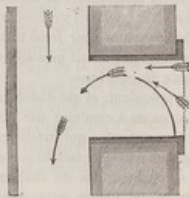


Fig. 8. — Ventilateur d'Arnott.

sous l'influence du vent, l'air et la fumée contenus dans

la cheminée tendaient à pénétrer dans la salle par la bouche d'extraction. L'aspiration produite par le courant d'air chaud qui monte dans la cheminée soulève le voile mobile et appelle l'air des parties supérieures de la salle.

Mais la quantité d'air extrait par la cheminée est toujours la même, qu'il y ait l'ouverture seule du foyer ou deux ou dix ouvertures; elle est en rapport avec la quantité de calorique développée par le foyer et non avec le diamètre des ouvertures par lesquelles la cheminée communique avec la salle. L'appareil d'Arnott serait un paradoxe s'il n'avait l'avantage de distraire quelques-uns des courants qui s'établissent dans les zones inférieures de la salle au niveau du foyer ouvert, pour les transporter vers les zones supérieures à la hauteur de la bouche d'extraction.

Si plusieurs cheminées provenant d'étages inférieurs passaient dans la muraille d'une salle, le système d'Arnott leur étant appliqué pourrait rendre de bons services; mais tant qu'on n'a à sa disposition que la cheminée du foyer de la salle, la ventilation ainsi obtenue doit être très-insuffisante.

Deux curieux appareils d'une remarquable simplicité sont ceux de Watson et de Mac Kinnel. L'appareil de Watson (fig. 9) se compose de deux tubes juxtaposés qui vont du plafond des salles au toit du bâtiment. L'air froid pénètre par un des tubes, s'échauffe dans la salle, se dilate et, devenant plus léger, monte et sort par l'autre. Jusqu'où peut aller la théorie! Pour que l'appareil fonctionne, il faut que les salles soient hermétiquement fermées! Fort heureusement pour les malades, elles ne le sont jamais, et il arrive alors que l'air, pénétrant par toutes les ouvertures qu'il trouve vers les parties inférieures des salles, sort par les deux tubes,



Fig. 9. — Ventilateur de Watson.

qui servent alors de bouches de sortie, tandis qu'ils pourront servir de bouches d'entrée si, les portes et les fenêtres étant bien fermées, il y a un bon feu allumé dans une cheminée ouverte.

L'appareil de Mac Kinnel (fig. 10) ne diffère du précédent que par la disposition des tubes qui sont concentriques et par leur différence de longueur, le tube central montant plus haut que l'autre et descendant un peu plus bas pour se terminer à une petite distance sous le plafond, par une cloison annulaire horizontale. Ce pavillon a pour but de diriger vers le plafond l'air qui pénètre par la gaine annulaire; l'air frais se disperse dans la salle, s'échauffe et sort par le tube central.

Fig. 10. — Ventilateur de Mac Kinnel.

On peut faire à l'appareil de Mac Kinnel les objections que nous avons adressées à celui de Watson.

On peut utiliser la force de propulsion du vent pour insuffler de l'air dans les salles de malades.

Le ventilateur de Muir (fig. 11), dont nous trouvons la description dans le rapport de MM. Blondel et Ser, se compose d'une cheminée carrée, divisée en quatre compartiments par deux cloisons verticales qui se coupent à angle droit; elle part du plafond de la salle et monte au-dessus du toit, où elle se termine par une lanterne garnie de persiennes sur ses quatre côtés. Le vent pénètre dans la gaine qui est dirigée de son côté, arrive dans la salle et sort par les gaines opposées.

Hammond décrit un appareil américain qui utilise l'action du vent d'une façon fort ingénieuse. Deux tubes ouverts partent, l'un du plancher de la salle, l'autre du plafond, et se rendent au-dessus du toit, où ils se recourbent à angle droit. Leur extrémité supérieure est garnie d'une girouette tournée pour le premier de façon à présenter son ouverture

au vent, tournée en sens inverse pour le second. Le courant atmosphérique pénètre dans le tube qui aboutit au plancher, se dégage par de nombreux orifices qui y sont pratiqués, traverse la salle de bas en haut et sort par le tube qui part du plafond.

Nous pouvons comparer ces deux appareils aux *manches à vent* de la marine; ce sont de longues gaines de toile à voile dont l'extrémité inférieure s'ouvre dans l'entre-pont ou dans la machine, et dont l'extrémité supérieure, s'élargissant sous la forme d'un pavillon dirigé vers le point d'où vient le vent, est attachée dans le grément du navire à une vingtaine de pieds au-dessus du pont. Sur mer, où il y a presque toujours du vent, ces appareils sont d'une utilité incontestable; mais sur terre ils fonctionnent d'une façon trop irrégulière pour qu'il soit permis de leur confier la ventilation d'un hôpital.

Nous empruntons à M. Léon Lefort la description des appareils de chauffage et de ventilation de l'hôpital de Glasgow.

« L'air frais entre dans les salles par trente-cinq ouvertures, sans compter les portes. Six orifices (trois de chaque côté) placés dans le plafond communiquent par un canal établi entre deux planchers contigus, avec un orifice s'ouvrant dans la façade. Les murs,

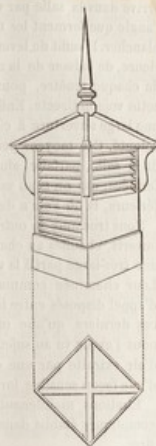


Fig. 11. — Ventilateur de Muir.

par une disposition analogue à celle qu'emploie le génie militaire dans la construction des magasins à poudre, sont en quelque façon dédoublés, et interceptent dans leur épaisseur une sorte de canal intrapariétal qui s'ouvre au niveau de la partie supérieure et de la partie inférieure des quatorze fenêtres. L'air pénètre ainsi entre les murs et arrive dans la salle par vingt-huit ouvertures placées dans l'angle que forment les murs latéraux avec le plafond et le plancher. Il suffit de lever de deux pouces la moitié supérieure, de baisser de la même quantité la moitié inférieure de chaque fenêtre, pour intercepter l'entrée de l'air par cette voie indirecte. Enfin, au-dessus de la porte se trouve une large ouverture à claire-voie qu'on ouvre et ferme à volonté. Ces moyens permettent une ventilation graduelle de la salle, parfaite, alors même que les fenêtres restent fermées, car on a pu ventiler les angles supérieurs et inférieurs, là où l'air a de la tendance à séjourner.

Nous trouvons en outre dans les salles deux vastes foyers ouverts, chauffés au charbon de terre, qui concourent pour une très-large part à la ventilation pendant la saison froide. Leur cheminée commune est en outre garnie de tuyaux d'appel disposés entre les deux foyers. Nous n'accordons à ces derniers qu'une médiocre importance, car, comme nous l'avons vu au sujet de l'appareil d'Arnott, la quantité d'air extraite par une cheminée ouverte n'augmente pas d'une façon sensible lorsqu'on agrandit son ouverture.

Étudions maintenant les appareils ventilateurs plus compliqués établis dans les hôpitaux de Paris et de Londres.

On peut les ranger dans deux grandes classes reposant sur des données très-différentes : 1° ventilateurs par propulsion; 2° ventilateurs par appel.

1° Ventilateurs par propulsion. — Leur mécanisme est

d'une extrême simplicité lorsqu'on le dégage de toute complication architectonique. Il repose sur le fait suivant :

Dans un tube ouvert aux deux bouts, où l'on fait tourner sur place une hélice, il se produit un courant d'air dont la direction et l'intensité dépendent du sens et de la rapidité du mouvement de rotation imprimé à l'hélice.

La forme, la longueur et la direction du tube au-dessus et au-dessous de l'hélice sont sans influence sur la quantité d'air qu'elle met en mouvement.

Qu'une des extrémités du tube débouche dans les salles d'un hôpital, l'autre s'ouvrant au dehors, l'appareil mis en mouvement pourra, suivant le sens de la rotation, aspirer l'air extérieur et l'injecter dans les salles, ou aspirer l'air des salles et le rejeter au dehors.

Deux hôpitaux sont pourvus, à Paris, d'appareils ventilateurs par propulsion : ce sont l'hôpital Necker, où est installé le système du docteur belge Van Hecke, et les pavillons de droite de l'hôpital Lariboisière, où sont placés les appareils à vapeur construits par Farcot (système fusionné des ingénieurs Thomas, Laurens et Grouvelle).

Nous ne décrivons pas en détail chacun de ces appareils; tous deux mis en mouvement par une machine à vapeur, ils peuvent fournir, été comme hiver, nuit et jour, de 80 à 100 mètres cubes d'air frais par heure et par malade. L'air injecté dans les salles est chauffé en hiver et se rafraîchit en été en passant dans des tuyaux souterrains; il s'échappe des salles par des bouches de sortie donnant dans des gaines verticales, établies dans la muraille et montant au-dessus du toit.

Les différences portent surtout sur le mode de chauffage et sur la prise d'air. Le système Thomas, Laurens et Grouvelle prend l'air à une assez grande hauteur, au haut de la tourelle de la chapelle, et l'échauffe au contact de tuyaux de vapeur et de poêles à eau chaude; le système Van Hecke

prend l'air au niveau du sol dans les jardins de l'hôpital, et le pousse, par son ventilateur, dans un calorifère à air chaud.

D'après M. Husson, « l'administration, sans se dissimuler les imperfections du système et certains vices des applications qui en ont été faites, est portée à penser que les procédés de M. Van Hecke méritent, jusqu'à ce jour, la préférence. » Mais M. Angiboust (1) fait remarquer, avec juste raison suivant nous, que l'atmosphère est d'autant plus pure qu'on s'élève plus haut, et que c'est au niveau du sol, dans une grande ville et dans un hôpital, qu'il est surtout chargé d'acide carbonique et de miasmes organiques. Il donne, sans hésiter, la préférence au système Thomas, Laurens et Grouvelle, qui prend l'air neuf dans les couches élevées de l'atmosphère.

A Paris, les appareils ventilateurs que nous venons d'indiquer n'agissent que par propulsion ; ils injectent dans les salles l'air frais du dehors, après l'avoir élevé, en hiver, à une température moyenne de 18° à 20° ; à Londres, à London fever Hospital, le ventilateur, qui a 1^m,20 de diamètre environ, est alternativement aspirant et soufflant. Pendant deux heures il injecte de l'air frais dans les salles de malades, et pendant deux heures, tournant en sens inverse, il aspire l'air vicié des salles et le rejette au dehors. On comprend que cet appareil ne saurait être appelé à concourir au chauffage ; c'est là un désavantage que ne saurait compenser la facilité que l'on a de renverser son action. Rien n'est moins prouvé, du reste, que l'utilité de son double mouvement.

2° Ventilateurs par appel. — Ils sont plus compliqués dans leurs dispositions que ceux qui agissent par propulsion, et

(1) Mémoire sur le chauffage et la ventilation des hôpitaux, p. 312.

ils présentent entre eux des différences assez tranchées. Les systèmes de ventilation par appel reposent sur les phénomènes physiques suivants :

Dans un tube vertical où l'on place une source de chaleur, il s'établit de bas en haut un courant d'air d'autant plus rapide que la quantité de calorique développée est plus grande. Ce tube devient une *cheminée d'appel* qui aspire l'air par son orifice inférieur.

Si des chambres à air et des salles de malades sont mises en communication avec l'orifice inférieur de la cheminée d'appel, l'aspiration qui s'y produit force l'air extérieur à les traverser pour se rendre dans la cheminée d'appel.

Donnons à notre tube la forme d'un siphon, l'air descendra dans la courte branche et montera dans la grande.

Si des salles de malades, s'ouvrant au dehors, sont situées sur la courte branche du siphon, le foyer se trouvant vers la partie la plus déclive, l'air traversera les salles, descendra dans le conduit qui leur fait suite, et montera dans la cheminée d'appel.

Dans les deux premiers cas, le système est droit et le foyer se trouve au-dessus du point par où l'air entre : c'est l'*appel en contre-haut*.

Dans les deux derniers, l'air qui traverse les salles descend d'abord vers le foyer, puis, changeant de direction, remonte dans la cheminée d'appel : c'est l'*appel en contre-bas* (*ventilation renversée*).

Les pavillons de gauche de Lariboisière sont ventilés par les appareils aspirateurs de Léon Duvoir et Leblanc (appel en contre-haut). Des chambres à air, chauffées par des poêles d'eau chaude, sont disposées dans les combles de chaque pavillon, sous une cheminée d'appel ; elles communiquent, par des conduits verticaux ménagés dans les murs et par des bouches d'appel, avec les salles de malades. L'air frais pénètre dans les salles par des conduits ho-

horizontaux qui s'ouvrent au dehors au niveau du plancher; il s'échauffe, en hiver, au contact d'un système de tuyaux et de poêles d'eau chaude, et sort par les bouches d'appel pour se rendre dans la chambre à air et de là dans la cheminée, qui le disperse dans les couches supérieures de l'atmosphère.

Dans l'hôpital militaire de Vincennes, deux systèmes sont en présence et fournissent des résultats à peu près identiques.

L'un des pavillons est chauffé et ventilé par les appareils aspirateurs de Grouvelle (appel en contre-bas pour le rez-de-chaussée et deux étages; appel en contre-haut pour le troisième étage). Le foyer de deux chaudières à vapeur destinées au chauffage des salles, des bains, de la buanderie, etc., aboutit à un tuyau de tôle vernissée qui monte dans une cheminée d'appel à environ 27 mètres du sol. De cette cheminée partent des conduits qui se ramifient dans les murs du bâtiment, et qui s'ouvrent dans les salles par deux séries de bouches d'appel, à 0^m,28 et à 2^m,50 du parquet, au milieu de chaque trumeau. L'air vient des caves dans des conduits placés dans les murailles et sous le plancher; en hiver, il est échauffé par les tuyaux de vapeur et les poêles à eau chaude des salles. Grâce à son excès de température, il monte vers le plafond, descend en se refroidissant, sort par les bouches d'appel et suit les conduits verticaux, qui se réunissent et forment un égout collecteur qu'il traverse pour monter dans la cheminée d'appel, chauffée par le tuyau de fumée des chaudières.

En hiver, lorsque les deux chaudières sont allumées, le chauffage et la ventilation se font bien; la température moyenne est de 15 à 18 degrés, et la ventilation est de 70 mètres cubes par heure et par malade. En été, on éteint celle des chaudières dont les tuyaux de vapeur sont spécialement destinés au chauffage des salles; le tuyau de fumée

ne développe plus dans la cheminée d'appel une quantité de chaleur suffisante pour activer la ventilation. On y supplée, il est vrai, en partie, en allumant un foyer ouvert au point de jonction de l'égout aspirateur et de la cheminée.

La ventilation du troisième étage se fait en contre-haut, comme à Lariboisière, par des poêles à eau chaude et des cheminées d'appel placées dans les combles. On a jugé, non sans raison, que l'aspiration de la grande cheminée ne se ferait plus suffisamment sentir à cette hauteur et à une distance aussi grande.

Dans le pavillon Est, le chauffage et la ventilation sont confiés aux appareils de M. Regnault, de l'Institut. Tout le bâtiment est divisé en segments de 12^m,5 de large, indépendants les uns des autres, chauffés et ventilés par un système de calorifère à air chaud, disposé de la façon suivante : deux fourneaux de calorifères à air chaud sont établis côte à côte dans les caves du bâtiment. Les tuyaux du plus grand des deux aboutissent, dans les salles, à des poêles qu'ils échauffent et d'où l'air se dégage par des bouches de chaleur pour monter, grâce à sa légèreté, vers le plafond et redescendre, en se refroidissant, le long de la muraille et autour des lits. Il est ensuite aspiré par les cheminées d'appel qui passent dans les trumeaux et s'ouvrent derrière les lits à 0^m,28 et à 2^m,50 du parquet.

L'appel se fait dans les cheminées d'appel par où sort l'air vicié, grâce à la chaleur que dégagent, dans celles de la muraille Est, un courant d'air chaud fourni par le plus petit des deux calorifères et son tuyau de fumée, et dans celles de la muraille Ouest, le tuyau de fumée du grand fourneau et un courant d'air chaud fourni par le petit calorifère.

Ce dernier se trouve donc chargé presque seul de la ventilation, puisque les deux courants d'air chaud et le tuyau de fumée qu'il envoie dans les cheminées d'appel n'ont

comme auxiliaire que le tuyau de fumée du calorifère chargé du chauffage des salles. C'est le seul qu'on allume en été; privé du secours qu'il recevait en hiver, il ne produit plus alors une ventilation suffisante.

Si nous comparons entre eux les différents systèmes de ventilation artificielle, nous sommes forcé de reconnaître que les appareils compliqués montés à si grands frais dans les hôpitaux de Paris sont très-supérieurs aux ventilateurs d'Arnott, de Watson, de Muir, etc., etc. Ils peuvent fournir en moyenne, et d'une façon à peu près régulière, de 40 à 120 mètres d'air frais par heure et par malade; les derniers, au contraire, n'ont qu'une action irrégulière et insuffisante.

Entre les appareils à appel et les appareils à propulsion, la comparaison est tout à l'avantage des derniers, qui peuvent agir, été comme hiver, avec la même intensité. Ils marchent aussi d'une façon plus régulière; leur prise d'air peut être portée à une grande hauteur, et jusqu'ici ils ont fourni, pour une quantité donnée de combustible, des chiffres plus élevés comme moyenne de ventilation. Nous avons déjà dit la préférence accordée par Husson aux appareils de Van Hecke; ceux de Thomas, Laurens et Grouvelle, à Lariboisière, ne viendraient qu'en seconde ligne.

Pour les ventilateurs à appel, la question est encore indécise. Si on les juge d'après le nombre de mètres cubes d'air qu'ils fournissent en été, les appareils de Regnault, de l'Institut, sont les plus défectueux de tous; ceux de Grouvelle, à Vincennes, et ceux de Léon Duvoir, à Lariboisière, leur semblent préférables.

M. Davenne, directeur honoraire de l'assistance publique (1), a publié des chiffres comparatifs établis entre les

(1) *De l'organisation et du régime des secours publics en France*. Paris, 1865.

trois systèmes qui fonctionnent dans les hôpitaux de Paris, et d'après lesquels l'avantage reste aux appareils de Van Hecke. Nous ne croyons pas inutile de rapporter ici ces quelques chiffres empruntés à des rapports officiels :

Quantité d'air renouvelé par heure et par malade.

Système Duvoir (en ne tenant compte que de l'air qui arrive par les canaux).....	39 m. c.
Système Thomas et Laurens.....	90
Système Van Hecke.....	97

Dépense de première installation par lit.

Duvoir.....	489 fr.
Thomas et Laurens.....	808
Van Hecke.....	236

Dépense annuelle de fonctionnement et d'entretien par lit.

Duvoir.....	54 fr.
Thomas et Laurens.....	101
Van Hecke.....	23

Pris de revient pour l'administration de l'unité de ventilation (800,760 d'air une fois donné, ou 1 mètre cube fourni par heure toute l'année).

Duvoir.....	3,36
Thomas et Laurens.....	1,76
Van Hecke.....	0,61

Mais comparons maintenant la ventilation artificielle avec la ventilation naturelle, et nous aurons lieu d'être étonnés de l'étrange faveur dont jouissent encore de nos jours les appareils ventilateurs.

On avait en eux une confiance telle que l'on ne croyait pas à l'insalubrité possible d'un hôpital où ils seraient installés. Grand a été l'étonnement, lorsqu'on s'est aperçu que la mortalité n'avait pas diminué à Beaujon et à Lariboisière d'une façon sensible après leur installation. En ce moment la réaction commence à se faire sentir, et déjà il ne manque pas de chirurgiens qui nient leur efficacité

d'une façon absolue. On allait au début jusqu'à recommander de fermer soigneusement les fenêtres pour que les appareils ventilateurs pussent bien fonctionner; aujourd'hui on est presque tenté de fermer les bouches d'appel des ventilateurs pour ouvrir plus largement les fenêtres.

Il faut reconnaître, en effet, que la ventilation naturelle par les fenêtres et les portes largement ouvertes est bien autrement active que la ventilation artificielle. Les chiffres approximatifs que nous avons donnés au commencement de cette partie de notre travail n'ont-ils pas montré d'une façon suffisante l'infériorité des machines, infériorité qui devient d'autant plus choquante que les sommes qu'elles ont coûtées sont plus considérables.

Mais, pour réduire les appareils ventilateurs à leur juste valeur, il n'est nullement nécessaire de les supprimer. Tant qu'on peut ouvrir les fenêtres, ils sont, il est vrai, complètement inutiles; mais pendant les longues nuits d'hiver, ils peuvent contribuer d'une façon efficace à la salubrité des hôpitaux. Quoique partisan déclaré de la ventilation naturelle, nous ne sommes pas de ceux qui voudraient voir dans les salles la température s'abaisser d'une façon presque constante, assez bas pour devenir préjudiciable aux malades et à ceux qui les soignent. Toutefois, nous croyons qu'on s'exagère beaucoup le danger du froid et des courants d'air: il faudrait, suivant nous, aller bien loin dans cette voie-là, pour augmenter le chiffre de la mortalité d'un hôpital.

VI. — Chauffage des hôpitaux.

Après le développement que nous venons de donner à la question de la ventilation artificielle des hôpitaux, celle du chauffage des salles se trouve très-simplifiée, car les derniers appareils que nous avons étudiés sont destinés au

chauffage et à la ventilation combinés; nous n'aurons plus que quelques lignes à leur consacrer.

En Angleterre et en Amérique, les salles sont chauffées par des foyers ouverts; ce sont, en général, de grandes grilles simples et appliquées contre le mur, ou doubles et adossées dos à dos, dans lesquelles, pendant la saison froide, on entretient nuit et jour un grand feu de charbon de terre dont la flamme vive et brillante éclaire et distrait les malades, qu'elle réchauffe par sa chaleur rayonnante. Ces grandes cheminées sont aussi, en hiver, un puissant moyen de ventilation; on ne se fait que difficilement une idée de la quantité d'air qu'elles aspirent, et nous ne pouvons même pas donner ici de chiffres approximatifs, car le tirage dépend de la hauteur de la cheminée, en même temps que de sa surface de section et de la quantité de calorique que développe le foyer. Qu'il nous suffise de dire que les 88 centièmes du calorique que développe la combustion servent à activer le tirage de la cheminée, et se trouvent par conséquent employés à la ventilation.

Les cheminées ouvertes sont très-défectueuses au point de vue du chauffage proprement dit; on ne profite guère que de la chaleur rayonnante qu'elles développent, environ 12 pour 100. Elles consomment par conséquent une quantité considérable de combustible dont les 88 centièmes sont perdus pour le chauffage, et dans les grands froids d'hiver, il devient assez difficile de maintenir dans les salles une température suffisante. C'est là la vraie raison qui les fait rejeter des hôpitaux de Paris. C'est une question d'économie, et d'après le savant mémoire de Husson, l'économie serait importante. Les hôpitaux de Paris dépensent en effet annuellement, pour leur chauffage, 350 000 francs environ, avec des appareils qui utilisent en moyenne 50 pour 100 de la chaleur dégagée. Pour obtenir la même température avec des cheminées ouvertes, il faudrait brûler cinq fois plus de combustible

« Il s'agirait donc d'augmenter le budget de notre chauffage au minimum de 1 050 000, au maximum de 1 400 000 fr. » On pourrait toutefois faire à M. Husson l'objection suivante. Est-ce bien pour le *chauffage des salles* que l'administration dépense 350 000 francs par an ? Si dans cette somme doivent figurer les cuisines, les buanderies, les tisaneries, etc., etc., et c'est ce que nous croyons, les chiffres indiqués ci-dessus sont beaucoup trop considérables. Nous ne demandons pas, en effet, que la cuisine et le blanchissage soient faits à un feu ouvert.

Dans les dernières discussions sur l'hygiène hospitalière, bien des médecins ont demandé qu'on établisse des foyers ouverts dans les salles de malades; nous nous joignons à eux, en admettant toutefois l'usage simultané des poêles ou de la vapeur; l'un n'empêche pas l'autre.

En France et en Allemagne on se sert surtout pour le chauffage des salles d'hôpital de grands poêles de fonte ou de faïence, dans lesquels on brûle de la houille ou du bois. On leur a fait bien des reproches; ils brûlent l'air ou plutôt le surchauffent, le dessèchent et diminuent ses qualités respiratoires; ils dégagent de l'acide carbonique et de l'oxyde de carbone. Utilisant 40 ou 50 pour 100 du combustible pour le chauffage, ils ne contribuent pas d'une façon suffisante à la ventilation; ils sont enfin d'un aspect sombre et triste. Mais la question d'économie plaide en leur faveur, et il est possible d'atténuer en partie les défauts qu'on leur reproche en les surmontant d'un petit réservoir d'eau et en les enveloppant d'une gaine munie de bouches de chaleur et communiquant au dehors par des conduits qui passent sous le plancher et traversent la muraille.

On se sert aussi comme moyen de chauffage de l'eau chaude, de l'air chaud et de la vapeur, circulant dans des réservoirs. Le calorifère de Duvoir-Leblanc (système combiné de chauffage et de ventilation) se compose d'une grande chaudière, où l'eau s'échauffe, et d'un circuit complet de

tuyaux conducteurs et de réservoirs qui communiquent avec la chaudière, à sa partie supérieure et à sa partie inférieure. L'eau en s'échauffant se dilate, et, devenant plus légère, tend à gagner les parties supérieures du système; elle redescend ensuite dans les réservoirs des salles en perdant son calorique et finit par revenir à son point de départ après avoir parcouru le circuit complet, qu'elle recommence dès qu'elle s'est de nouveau chargée de calorique. Il y a donc, dans tout l'appareil, un courant continu d'eau chaude qui porte, dans tout le bâtiment, la chaleur développée par le foyer de la chaudière.

L'eau ayant une capacité calorifique considérable, est un excellent moyen de transporter, dans tout un hôpital, la chaleur que développe un foyer unique. Les tuyaux et les réservoirs qui la contiennent peuvent céder aux parties environnantes et à l'atmosphère des salles, des quantités considérables de calorique sans se refroidir d'une façon sensible. Le foyer peut être éteint plusieurs heures avant que la température ne s'abaisse d'une façon notable dans les pavillons chauffés par des appareils à eau chaude. C'est de plus un moyen de chauffage qui a l'avantage de ne pas surchauffer l'air des salles et de ne lui communiquer aucune propriété nuisible; mais les frais de première installation sont très-élevés, les fuites d'eau se produisent facilement et l'entretien de tout le système est difficile et dispendieux. En résumé, les calorifères à eau chaude présentent plus d'avantages que d'inconvénients, mais au point de vue de la ventilation, ces appareils, comme nous l'avons vu, laissent à désirer.

A volume égal, la vapeur contient 288 fois moins de chaleur que l'eau élevée à la même température. Aussi les appareils qui n'ont comme moyen de chauffage que des tuyaux de vapeur se refroidissent-ils très-vite, et ils permettent dans les salles des abaissements brusques de température. On a obvié à cet inconvénient en combinant la

vapeur et l'eau de la façon suivante (appareil de Grouvelle, à Vincennes). Les tuyaux de vapeur, placés dans un caniveau, sous le parquet des salles, viennent aboutir à un serpent in contenu dans une grande caisse pleine d'eau, véritable réservoir de chaleur. Ce poêle à eau chaude, que la vapeur échauffe, est fait de forte tôle et timbré à deux atmosphères. La vapeur, en le quittant, est conduite par des tuyaux dans un réservoir où elle se condense, pour retourner ensuite dans la chaudière.

Le chef de bataillon Benoit (1) fait remarquer que ces réservoirs, où la température peut s'élever à plus de 100°, subissent une pression assez forte pour les faire éclater, lorsqu'ils auront perdu par l'âge une partie de leur résistance actuelle. Un autre inconvénient, mais de peu d'importance, est le gargouillement que produit dans les tuyaux l'eau provenant de la vapeur condensée, lorsque après avoir laissé refroidir les appareils, on y lâche brusquement de la vapeur. En somme, les appareils à vapeur sont passibles des mêmes reproches que les calorifères à eau chaude; ils nous semblent aussi présenter à peu près les mêmes avantages.

Il ne nous reste plus à examiner que les calorifères à air chaud. Sous ce nom, nous ne comprenons que les appareils dans lesquels l'air est chauffé par un fourneau à une certaine distance des salles des malades. Si, d'une manière générale, le système est toujours le même, les résultats sont très-différents, suivant les appareils, au point de vue de la vitesse de la température et de l'abondance des courants d'air chaud qu'ils fournissent. L'air pris dans les caves ou dans les jardins de l'établissement arrive dans des tuyaux de tôle ou de fonte chauffés par un fourneau ardent. Il y acquiert une température élevée et passe, de là, dans des conduits qui aboutissent aux salles des malades. L'air traverse donc le feu, protégé par une enveloppe métallique

(1) *Mémoires de l'officier du génie*, 1865.

chauffée en général au rouge sombre, et à laquelle on donne le nom de surface de chauffe. L'expérience a démontré que la proportion doit être de 1 mètre carré de surface de chauffe pour 200 mètres carrés de la capacité à chauffer. Dans les appareils de Regnault établis à Vincennes, cette proportion n'est pas atteinte, même en faisant concourir au chauffage le fourneau destiné à la ventilation; aussi, lorsque les salles sont vides, on ne peut pas arriver à y maintenir en hiver une température suffisante.

Les calorifères à air chaud présentent, au suprême degré, tous les défauts des poêles chauffés à la houille ou au bois. L'air qui a passé sur des plaques rougies est desséché, impropre en quelque sorte à la respiration; il est privé d'ozone, il a perdu de son oxygène et contient presque toujours un excès d'acide carbonique et d'oxyde de carbone dû à la combustion des particules organiques qu'il contenait. Lorsque le chauffage se fait avec de la houille, il est rare que les tubes qui contiennent l'air soient assez bien fermés, du côté du fourneau, pour empêcher l'entrée d'une certaine quantité de fumée et de gaz sulfureux, dont la présence nous est révélée par l'odorat, et noircit assez vite les objets d'argent exposés aux bouches de chaleur.

Il est quelques appareils qui échappent en partie aux reproches que méritent le plus grand nombre des calorifères à air chaud : ceux de Van Hecke (1) n'élèvent pas la température de l'air dans les insufflateurs à plus de 30°, et cependant la chaleur est suffisante l'hiver, dans les salles de malades, grâce à l'activité de la propulsion; de plus, ils rendent en partie à l'air la vapeur d'eau qui lui manque. Nous ne croyons pas toutefois que l'air ainsi manipulé

(1) Voy. Vernois, *Note sur le nouvel appareil de ventilation et de chauffage établi à l'hôpital Necker, d'après le système du docteur Van Hecke* (*Ann. d'hyg.*, 1859, 2^e série, t. XI, p. 30), et Grassi, *Étude des appareils de chauffage et de ventilation établis à l'hôpital Necker* (*Ibid.*, p. 39).

vaile l'air pur du dehors : il faudrait pouvoir échauffer l'air sans l'altérer. Il y a là un dilemme; qui pourra le résoudre?

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- Discussion sur l'hygiène des hôpitaux à l'Académie de médecine:*
MM. Davenne, Gosselin, Bouvier, Malgaigne, Bonafont, Piorry, Renault, Husson, Devergie, Larrey, Marjolin, Nonat, Trébuchet, Briquet, Michel Levy, Tardieu, Velpeau, Desormeaux (*Bulletin de l'Académie de médecine*, Paris, 1861-62, t. XXVII, passim);
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Paris. — Imprimerie de E. MARTINET, rue Mignon, 2.

THE
ESSENTIALS OF A HEALTHY DWELLING,

AND THE
EXTENSION OF ITS BENEFITS TO THE
LABOURING POPULATION.

WITH
A SPECIAL REFERENCE TO
THE PROMOTION OF THAT OBJECT
BY
H.R.H. THE LATE PRINCE CONSORT.

BY
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ETC.

LONDON:
J. RIDGWAY, 109, PICCADILLY.
1862.

ESSENTIALS OF A HEALTHY DWELLING.

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LABOURING IMPROVEMENT.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS STREET,
COVENT GARDEN.

HERE THE LATE LADY CORNISH

HEALTHY DWELLING.

THESE PAGES CONTAIN THE RESULTS OF THE AUTHOR'S RESEARCHES INTO THE CAUSES OF THE PREVALENT DISEASES OF THE POOR, AND THE MEANS OF PREVENTING THEM.

LONDON:
SAVILL AND EDWARDS, PRINTERS, CHANDOS STREET,
COVENT GARDEN.

PREFACE.

THE following paper, although primarily addressed to a scientific body, was written with a view of diffusing more widely useful practical information, as well as of stimulating to increased efforts for the accomplishment of its much-needed object.

Whilst passing through the press, the announcement has been made of an unprecedented act of munificence on the part of an American merchant resident in London. In order "to ameliorate the condition and augment the comfort of the poor, who form a recognised portion of its population," George Peabody, Esq., has placed 150,000*l.* in the hands of Trustees, with the suggestion "to apply the fund, or a portion of it, in the construction of such improved dwellings for the poor as may combine, in the utmost possible degree, the essentials of healthfulness, comfort, social enjoyment, and economy."

The writer, in personal intercourse with a much-esteemed Ambassador from the same country—the late Mr. Abbott Lawrence—learnt the great interest he felt in this object, and which was afterwards manifested by a bequest of 50,000 dollars, for the building of model houses in Boston, U.S.

Both these funds, so administered as to avoid the evils which generally result from eleemosynary assistance, may doubtless be made the means of imparting, to an almost incalculable extent, the benefits intended by their philanthropic donors.

Whilst such examples encourage greatly the efforts made for placing this subject prominently before the public, the Author of the following pages, aware of some of the benefits which have resulted from those made in 1851, desires again to take advantage, as far as may be in his power, of the opportunities presented for that purpose at the concourse of persons attracted from all parts of the globe by the approaching Exhibition.

To those, more particularly, who will take a part in the meetings of the National Association for the Advancement of Social Science, and of the Congrès International de Bienfaisance, to be held conjointly in the Metropolis, the Author inscribes the following pages, as to fellow-labourers in the field of social improvement.

ATHENÆUM CLUB,
PAUL MALL, April, 1862.

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THE ESSENTIALS OF A HEALTHY DWELLING

AND THE
EXTENSION OF ITS BENEFITS TO THE
LABOURING POPULATION.

READ AT
THE ROYAL INSTITUTE OF BRITISH ARCHITECTS,
20th January, 1862.

In acceding to the request of the Institute that I would, after an interval of twelve years, again give to its members some of the results of that experience which has been gained in my gratuitous efforts to promote the healthfulness of our dwellings, and more especially those of the labouring population, I feel that, however unattractive the subject may be in an artistic point of view, it has some peculiar claims on your attention, and that whilst many of the difficulties with which it is beset can be appreciated, their solution may probably be aided by some amongst those I have now the pleasure of addressing.

In my paper read the 21st January, 1850,* reference was made to the great interest taken in this subject by our late illustrious patron, the deeply lamented Prince Consort, and his Royal Highness's own words were quoted, to show that "these feelings are entirely and warmly shared by Her Majesty the Queen," our most gracious patroness. Proofs of an undiminished continuance of that interest, as well as some of its practical results, will be stated in the second part of my present paper.

It would be doing violence to your feelings as well as to my own were this allusion to be unaccompanied by an expression of the most profound sympathy with our beloved Sovereign, for whom we earnestly pray that in this time of overwhelming grief abundant consolation may be granted from above. Shall we not also indulge the hope that the gradual development of the great and wide-spread

* This paper was published, with numerous illustrative plates, by the Society for Improving the Condition of the Labouring Classes in 1850, under the title of "The Dwellings of the Labouring Classes, their Arrangement and Construction;" and it has, in a French translation, made by order of the Emperor when President of the Republic, been widely circulated in France. Considerable portions of it have also been published in Germany and in the States of North America. The third edition, 6th thousand, contains much supplementary matter.

benefits resulting from the noble principles, highly practical wisdom, and bright example, which, alas! we must now speak of as a precious legacy left by his Royal Highness for the good of his family, his adopted country, and the world at large, will have a soothing influence on our bereaved Queen, as well as stimulate many to follow so bright an example!

In the grief so universally manifested at the death of this great and good Prince we all participate; but those who were honoured by occasional intercourse with that illustrious person, and knew his kindly, courteous manner, must feel the loss more deeply. Some present can, no doubt, bear witness with me to the proof of real interest in the objects his Royal Highness deemed worthy of his attention, which was manifested by a remarkable appreciation of minute details—a characteristic feature, if it be permitted me to say so, of a mind as reflective as it was highly cultivated.

A suggestive motto, suited to the subject before us, might be easily selected, from one of the admirable addresses by his late Royal Highness, which it was my privilege to hear at the Aberdeen meeting of the British Association, and at the International Statistical Congress, held more recently in London; but I prefer adopting for that purpose a sentence uttered on another occasion by the ever to be lamented Prince, on account of the deep feeling of responsibility which it manifests, and the important principles so peculiarly applicable to my subject. It is the following:—

"The blessings bestowed on us by the Almighty can only be realized in proportion to the help which we are prepared to render to each other."

In proceeding to point out the circumstances conducive to the healthfulness of a dwelling, some will be named which cannot be strictly termed "essentials," inasmuch as their absence may be compensated for. Such is the case where localities, though not elevated, have a good soil and are well drained. It may, perhaps, appear scarcely necessary to add that the healthy state of a dwelling will not be ensured by any one, or even by the union of several of the features essential thereto, in the absence of others which are of equal importance.

The condition of "healthy," in regard to dwellings, arises out of a combination of circumstances, which comprise—

1. Those appertaining to the locality, including a free circulation of pure air, a good soil, an efficient drainage, an ample supply of pure water, and a genial aspect.
2. Those which are structural.
3. Those which depend mainly, though not wholly, on the occupants themselves—external and internal cleanliness, and a proper use of structural arrangements.

Firstly.—IN REGARD TO LOCALITY. High and dry situations, having a free circulation of air, whether occupied by groups of buildings, as in towns, or by isolated dwellings, as in the country,

are proverbially healthy; whilst those which are low and damp, or surrounded by confined air, are the opposite. Experience, afforded by the state of troops when encamped, or when in permanent barracks, or in hospitals, is conclusive on this point. It is a known fact that the mortality of troops in Jamaica has been diminished from 120 to 20 per thousand by their removal from the plains to the hills; and it is well ascertained that ague, dysentery, and fever prevail in localities where the surface of the ground is naturally wet and insufficiently drained, or where there exists an accumulation of decaying matter, of which one sure indication is the presence of an abundance of flies. Dampness of situation is also productive of mental depression and bodily feebleness, which excite a craving for intoxicating drink. The embosoming in trees, or any other obstruction to a free circulation of air immediately round a dwelling, is prejudicial to health, and should, therefore, be avoided.

A soil of gravel is unquestionably the most healthy, and, next to it, one of sand. A soil of chalk is usually attended with the disadvantage of its being necessary to sink a considerable depth for water; whilst the chemical properties,* imbibed in the process of filtration, are injurious to some constitutions. Tanks, or reservoirs for storing rain-water are, in such cases, often the most suitable expedient. Clay soil, which, from its non-porous nature, retains the rainfall, is a frequent cause of the dampness so prevalent in the lower stories of houses in many localities—an evil felt as much in some which are elevated as in those at a lower level, and a fruitful source of sickness amongst servants, as well as the occupants of small houses, whether in towns or in the country. The precautionary measures which should be adopted when the soil is of clay will be noticed under the head of construction.

Loose soil close to a house is a frequent cause of damp, which might be remedied by a flagging of stone or asphalt, and in many situations a dry drain or area ought to be formed round the building. Care should, therefore, be bestowed in regard to the surface of the ground about a dwelling, as well as in the selection of its site.

Drainage of the Soil and Surface.—Wherever dwellings are built on naturally wet ground, it is essential to their being healthy that ample provision be made for draining the soil, as well as for ordinary surface drainage and for the carrying off of surplus fluid from the house itself. The necessity for this description of drainage is generally more manifest in the country than in towns, their gradual formation and progressive increase having been

* A process for softening water derived from chalk has been put in operation at Woolwich, and is said to be successful. In an article on sanitary legislation in England in the *British Almanac* for 1859, this process is noticed, and also the serious inconvenience often occurring from the oxidation of iron pipes used for soft water supplies, the only known effectual remedy for which is an internal coating, or varnish.

usually accompanied with surface drainage under some form or other. Good surface drainage is, however, peculiarly necessary in towns built on an uneven surface, as is the case with the metropolis, which stands on low hills in the midst of an imperfectly reclaimed swamp, partially underlaid by a stratum of peat. The lower levels on either side of the Thames, where the drainage has been most inefficient, were much more severely visited by the cholera than the higher parts of the metropolis.*

House Drainage.—The providing efficient means for house drainage, as well as a good surface drainage, is a duty which, in the case of towns, obviously devolves on the public authorities. The consequences of a past neglect of this duty have been remarkably manifested at Windsor, where the prevalence of fevers and choleraic complaints having led to an investigation, the drainage of the town was found to be very defective, and without any proper ventilation to carry off the gases which form in the sewers; whilst, on the contrary, at the Castle,† a separate and perfect system of drainage having been provided, no disease existed. The case of Bedford might be cited as another instance recently before the public. House drainage should, as far as possible, be kept without the building, although the valuable modern improvement of glazed earthenware tubes with perfect sockets has greatly diminished the risk of leakage from defective drains, an evil formerly so prevalent. Especial care ought to be taken that the pipes which discharge into them are properly trapped, in order that they may not become a medium for the escape of foul air into the dwelling. It may be useful to point out the disinfecting properties of wood charcoal, now successfully applied as a medium of filtration in ventilating sewers, house drains, &c.

Cesspools under basement floors, so common formerly, have been the cause of sickness and deaths innumerable. During the cholera in 1849, to my knowledge, several cases wholly traceable to this cause occurred in one house. Whenever these latent sources of mischief are discovered, they should be removed as quickly as possible. In many houses of the first magnitude, both in the metropolis and in the country, which are not of recent construction, this evil exists, as well as that of defective drains, causing the ground under the house to become sodden with fetid matter. The gases which originate in these places, and diffuse themselves

* I have the authority of Dr. Farr for stating that, if the mean of cholera epidemic of 1848 and 1854 in London be taken, nearly 11 per 1000 of those living under 10 feet of elevation died, to 1 per 1000 of those at the highest elevation; and that if London be divided into terraces of different degrees of elevation, the mortality from an epidemic of cholera is, in round numbers, inversely as the elevation.

† The official Report made by Mr. Rawlinson, since the reading of this paper, entirely confirms the fact here stated. The perfection referred to is attributable to the thoughtful care of the lamented Prince Consort.

over the dwelling, constitute one of those conditions of local impurity which exercise a powerful influence when the state of the atmosphere is favourable to an outbreak or spread of cholera, fever, or other kindred complaints. The abolition of cesspools within all dwellings is therefore a sanitary measure of the first importance.

Pure Water.—For an ample supply of pure water, one of the most important accessories to a healthy dwelling, the public authorities should, in the case of towns, be held responsible. The contamination of our rivers by their being unscrupulously, and at the same time most wastefully, made the receptacles of sewage, has rendered them very generally incapable of supplying the neighbouring population with pure water. Fully admitting the improvement which, in respect to its supply of water, has taken place in our own metropolis, it still remains far behind the metropolis of the Roman Empire, and even many of its provincial cities. Those who have traversed the Campagna di Roma can never forget the gigantic aqueducts whose ruins proclaim how abundantly and at what cost Rome was supplied with water. The water from Loch Katrine recently brought to Glasgow, at a cost of 1,500,000*l.*, contains only 2.35 grains of impurity per gallon, whilst the water supplied to London by six of the leading companies is shown, by late official returns, to contain from 17.72 to 21.76 grains. The practice which has to such an extent prevailed in our towns of obtaining water from wells, sunk not unfrequently near to a churchyard, has been very prejudicial to health, though its sparkling appearance and freshness to the taste might lead to the contrary supposition. Its impurity is generally caused by an infiltration from some neighbouring drain, cesspool, or other deposit of putrefying matter. Many such instances in the metropolis might be referred to. One was recently mentioned to me by the medical officer to the General Post Office as having been the cause of much internal derangement to several of the *employees* in that establishment, and which had led to his recommending the use of the patent carbon filter. In late reports of the Registrar-General reference is made to a well at Sandgate as containing 40.96 grains of impurity per gallon; and in another at Hampstead as containing 53.60 grains.

For dwellings in the country good drainage and ready access to pure water are not less essential than they are in towns, and they ought, therefore, to be made the subject of deliberate investigation before the locality of a dwelling is decided on.

The aspect of dwellings is often greatly dependent on local circumstances, and has an influence on their salubrity which is too much overlooked. In preference to all others, a southern aspect should be chosen, and where that is unobtainable, one inclining either to the east or to the west, so that the rays of the sun may enter at some part of the day. Rooms to be chiefly occupied in the height of the summer are exceptional, though in such cases I should give the preference to an eastern or a north-eastern over a

due northern aspect. In towns the difficulty of obtaining a sunny frontage may frequently be great, if not insurmountable, but the importance of having the sun's rays within the dwelling for some portion of the day, especially in rooms occupied by children or by invalids, should never be forgotten. I could point to a large convalescent asylum in the country which is so arranged that the spacious gallery used by the patients for exercise during the greater part of the day is without the cheering and warming rays of the sun. Such defects tend to defeat the main object of the institution, and are a discredit to all concerned in the building.

Secondly.—The structural features essential to a healthy dwelling have now to be considered. In pointing them out I shall aim at the same brevity which has characterized my remarks on those appertaining to locality; and not doubting that your own recollections will supply the corroborative passages which might be adduced from Vitruvius, from Alberti, and other eminent authorities, I abstain from quoting them, in order to avoid unnecessarily encroaching on your time and patience.

To secure the healthy condition of a dwelling its structure must be—1. Dry. 2. Warm. 3. The number and area of its apartments must be in proportion to the number of their occupants, and due provision must be made for all the requisites appertaining to daily life. 4. It must be well lighted. 5. It must be properly ventilated, and be free from noxious vapours of every kind.

1. In order to a house being dry, it must stand on a dry foundation; and where this is not otherwise obtainable, artificial means should be adopted, either by forming a stratum of concrete, varying in depth according to circumstances, but never less than 12 inches;—by a bedding of slate in cement, or by a bed of asphalt laid through the whole thickness of the wall under the floor level.

The lowest or basement floor should be raised not less than about 8 inches above the external surface, and if the floors are of wood, the ground beneath them ought to be excavated, so as to give a clear depth of not less than 12 inches, which should be ventilated by means of air bricks, built in the external walls.

Floors of stone or of slate should either be hollow, resting on brick courses, or be laid on a dry bed, prepared for the purpose, which is also essential in the case of brick or tile floors. In some parts of the country lime and sand floors are pretty generally used for cottages, and when properly made with a dry substratum are said to last upwards of 40 years. I have used Portland cement for the floors of living rooms in fireproof dwellings, but in those places where there is much wear stone is preferable. Bed-rooms ought, in our climate, when not matted or carpeted, to have boarded floors.

External walls must be weather proof, of sufficient thickness to

secure dryness and warmth. On the facilities for obtaining a good and non-porous material may depend whether brick, stone, or flint be used; whichever it be, good mortar is essential to dryness. In some places concrete, pisé or cob, with an external facing of plaster, or rough cast, may be employed with advantage, provided the foundation be dry, and the walls are well protected by an overhanging roof. Hollow walls conduce greatly to dryness and warmth; they may be formed either wholly of brick, or externally of one of the other materials before named, and be lined with brick or tile, a small hollow space being left between. The same advantages are derivable from the use of hollow bricks, and they are also well adapted for the lining of walls. A glazing on the external surface of brickwork is an effectual preventive of damp, and it is to be regretted that suitably glazed bricks are not easily obtainable at a moderate price. Their smooth surface is a great recommendation for some internal work, on account of its cleanliness and its non-retaining properties of noxious odours. Colouring or whitewash is more healthful than paper in common apartments, and should be frequently renewed.

For the covering of roofs, slate has with us so many recommendations that its general adoption may be readily accounted for; the evils attendant on its use, arising from changes in the temperature, should be particularly guarded against by boarding, by felt, or by double plastering. Tiles are generally found to be warmer in the winter and cooler in the summer than slate, and requiring less lead are in that respect more economical. Projecting eaves should invariably have gutters, to prevent the drip which is often the cause of damp in the walls and foundations; the same evil too frequently arises from a stoppage of the rain-water pipes consequent on their being either too small, or their heads being unprotected from the intrusion of birds' nests, leaves, &c.

For the roofs of town buildings more particularly, a fire-proof construction,* such as was described in my paper of 21st January, 1850, has many obvious advantages to recommend its general adoption. But the practice, so extensively prevalent, of forming rooms for servants in the roof has an opposite tendency. In reference to fire-proof constructions I would take this opportunity of recalling a suggestion in a Paper read by my friend Mr. S. Smirke, 5th November, 1860, "On the Use of Coke," which, from its lightness

* I adopted the hollow-brick fire-proof construction here referred to, in the roof and floors of the two ranges of model dwellings for families built in Streatham-street, Bloomsbury, and in Portpool-lane, as well as in the late-mentioned Prince Consort's model houses at the Exhibition of 1851. Recently the efficacy of this mode of construction was tested at the Streatham-street houses, by a tenant who accidentally set fire to the woodwork of his apartment, to which the fire was limited. Hollow bricks, with wrought-iron girders, are now very extensively used for floors in Paris. Thirty years since, when constructing Fishmongers' Hall, I used, over the kitchen and in some other places, a vaulting of earthen pots, hollow bricks being then scarcely known, though they have been found in the remains of Roman buildings in this and other countries.

appears to be equally suitable for the purpose of vaulting, as the volcanic scoria or pumice known to have been thus applied in many important buildings in Italy and Sicily.

When the immense destruction of property caused by fire, and too often accompanied by the loss of life, is considered, the question of an efficient system of fire-proof construction generally applicable, appears to me to merit the very serious consideration of the Institute of British Architects, and I therefore venture this passing remark, though the suggestion is not immediately connected with my subject.

Wood of an inferior quality, or unseasoned, when used in any part of a dwelling-house is a false economy, whilst the cracks and shrinkages caused thereby are, from the draught they occasion, often prejudicial to health.

Lead, a material which enters into the construction of most dwellings, should be used with great caution for pipes which convey drinking water, and ought to be dispensed with altogether for cisterns, excepting those for the service of closets, on account of the injurious effects produced by the chemical action which frequently takes place when the water in them is soft. Iron, properly varnished or enamelled, may be substituted for both purposes; and for cisterns, slate is very suitable. The offensive and unwholesome smell which often proceeds from sinks of lead or ordinary stone, renders the substitution either of slate, of glazed stone-ware, or of enamelled iron, very desirable.

2. *Warmth.*—This in a dwelling depends, not only on its aspect, its dryness, the materials used, their proper application and substance, as I have already noticed, but also on the structural plan, particularly on the relative position of the doors and fireplaces, as well as of the windows and spaces for beds, which should be so contrived that the occupants will not be exposed to draughts.

With all our regard for comfort, it is surprising that we do not more frequently endeavour to modify the effects of our variable climate by the use of double sashes, which are so common in many parts of the Continent. This would be a means of retaining more of the small portion of genial warmth which passes into the room from our wastefully constructed open fireplaces, a subject on which, in connexion with the artificial warming and ventilation of dwellings, something more will be said hereafter.

3. *The number and dimensions of the apartments essential to health in a dwelling,* must be proportionate to the number of its occupants, and suitable provision must be made for all that appertains to a well ordered domiciliary life, not only that of the master and mistress as well as of the children, but also that of the servants, whose health and morals it is the duty of their employers to care for.

The amount of space required for health being greatly dependent on efficient ventilation, it will be considered under that head. In most dwellings the scale of accommodation chiefly depends on the

means and circumstances of the occupants, in which the variety is so great that I shall not attempt giving anything but a brief outline of what may be termed the minimum provision which ought to be made for a family consisting of parents and children of both sexes, belonging to the labouring class, undoubtedly the most numerous section of the community.

A *labourer's dwelling* in the country should have a small entrance lobby, a living room not less than 150 feet in area, and a scullery of from 60 feet to 80 feet in area, in which there should be a stove or fireplace for use in summer, as well as a copper and sink; there should also be a small pantry. Above should be a parents' bedroom of not less than 100 feet area, and two sleeping-rooms for the children averaging from 70 to 80 feet superficial each, with a distinct and independent access. Two of the sleeping-rooms at least should have fireplaces. There ought also to be a properly lighted, ventilated, and drained closet, as well as suitable enclosed receptacles for fuel and dust. The height of the rooms, in order to their being healthy, should be scarcely less than 8 feet, and even 9 feet would be desirable but for the extra expense. With a view to ventilation, the windows should reach nearly to the ceiling, and the top be invariably made to open. In windows which have transoms as well as mullions, some of the upper compartments may be hung on centres for this purpose.

It may be deemed almost Utopian to indulge the hope of seeing such accommodation as this, placed within reach of those of the labouring population who are doomed to reside in towns; but they who for several years have been striving to place the benefits of a healthy dwelling within their reach, whilst knowing by experience something of the numerous difficulties to be overcome, and being fully aware that, in many cases, it may be impossible to accomplish all that is desirable, ought not on that account to be daunted in the pursuit of an object of such great and wide-spread importance.

In returning from this digression to the structural features of a healthy dwelling, I would point out the great importance of direct external ventilation and light to all water-closets, including those in servants' use. It is obvious that constructive defects here must be a very serious evil. The water-pipes should be carefully protected from the effects of frost. I notice also that it is of much importance the *chimneys* should draw so that the smoke will properly ascend; when it does not, the air is greatly contaminated by its escape into the dwelling. The smoking of chimneys, if not caused, as it often is, by the want of sufficient air in the apartment,* or by bad management in the first lighting, or in the putting on of

* The late Mr. Thomas Cubitt told me that he had frequently cured smoky chimneys, in houses of his own building, well known to be amongst the best in London, by an imperceptible admission of a little air over the room doors, the woodwork fitting so closely that when they were closed sufficient air could not gain admission to the room.

fuel, frequently arises from the proximity of more lofty buildings, or of trees, and too often from a defect in the construction, such as being too large to ensure a continuous upward current—an evil which may be sometimes cured by a contraction of the throat. For ordinary chimneys, flues 9 inches square, or, which is decidedly preferable, 10 to 11 inches diameter, are quite sufficient. Those for rooms above the ordinary size and for kitchens are exceptional. The dampness of flues in a thin external wall is often the cause of their smoking.

4. *Light** well diffused over all parts of a dwelling is essential to its being healthy. A dark house is not only gloomy and dispiriting, but is always unhealthy. We know on high medical authority that "the amount of diseases in light rooms as compared with dark ones is vastly less." Light ought to be diffused over the whole dwelling, so that no dark corners be left to invite a deposit of that which is untidy or offensive. Happily the motive which in times past led so much to an exclusion of the light of heaven no longer exists, and though ages may pass ere the evils resulting from a vicious legislation are entirely swept away, yet the removal of the tax on windows and of that on glass, must, amidst much to discourage those who have long and zealously laboured in the cause of sanitary amelioration, be regarded as most valuable concessions in its favour.

5. *Ventilation and Artificial Warming*.—These are questions of vital importance in regard to dwellings, though, judging from the neglectful indifference of multitudes, their value is far from being duly appreciated by the educated, and even by some in the scientific classes of the community. Were it otherwise, the closeness perceptible on entering many of their dwellings, the oppressive heat of the rooms, the sickening fustiness in the apartments occupied by the servants, and too often in those of the children, would certainly not exist. When the number of hours passed within doors by every human being in a civilized state is considered, it will be manifest that the breathing of vitiated air for so large a portion of the twenty-four hours must be as injurious as living on unwholesome food.

Unnecessary as it is for me to describe the component parts of the air,† the process of its deterioration in passing through the lungs, or to dwell further upon those sources of impurity and other

* Although the influence of light on physical life is a subject on which but little is known, some important facts are recorded. Sir James Wyllie, who studied at St. Petersburg the effect of light as a curative agent, found in hospital rooms in that city, which were without light, that only one-fourth the number of patients left cured, as compared with those who had occupied properly lighted rooms.—*Vide* an article by Sir David Brewster in the *North British Review*, vol. xxix., 1858, entitled "Researches on Light."

† Amongst the numerous works which may be consulted on this and other important questions connected with my subject, I would recommend "The Principles of Physiology applied to the Preservation of Health," by Dr. Andrew Combe; or the more popular publications by Dr. Leakester and by Jarrold & Co.

accessory influences in and about a dwelling which tend to vitiate the air within, it may be useful, before giving the results of my own observations on the means of obtaining efficient ventilation, that I should notice one important preliminary consideration, that of the space required to keep a healthy man in full vigour, on which very different opinions have been expressed. Experience gained in poorhouse dormitories, in prisons,* &c., has led to the conclusion that from 450 to 500 cubic feet are requisite thereto, and that the ventilation should be such as will cause an entire renewal of the air about once in the hour.

Observations made at the Model Lodging-house, in George-street, St. Giles's, a confined situation, satisfy me that the cubical space of 535 feet, which is provided in the dormitories of that building for each inmate, is, with proper ventilation, abundantly sufficient to render them healthy; such was proved to be the case, even when the cholera raged in the neighbourhood, and had not a single victim out of the 104 men who lodged within its walls. From this fact I think it reasonable to infer that the unhealthiness of the Wellington Barracks, Westminster, where the cubical space per man allowed in the dormitories is stated to be 500 feet, must have arisen, not from want of space, but from some other existing evils, particularly the defective ventilation pointed out in the report made to the General Board of Health by the Commission on Warming and Ventilation.

As mistakes with regard to space tend to create imaginary difficulties, and either impede sanitary reform, or cause a serious unnecessary expenditure,† I think it of use to notice two recent errors on this point which have come under my observation—one in the *Quarterly Review*, where, in an article on "Labourers' Homes," it is stated that "The Lodging-house Act requires an allowance of

* The space allowed in the cells of prisons should not be regarded as an absolute criterion; at the Model Prison, Pentonville, there are about 800 cubic feet.

† The Report of the Government Commissioners on Warming and Ventilation says, at folio 92:—"Under all the circumstances, we would urgently direct the attention of the Minister-at-War and the Horse Guards to the absolute necessity of providing more room and accommodation for the soldier in barracks; and that instead of 500 cubic feet of space, that 700 to 800 cubic feet should be allowed per man, or, as in the case of the Wellington Barracks, that only ten persons should occupy the space allotted to sixteen; and that these regulations should be enforced as soon as extra spaces can be provided throughout the whole of the United Kingdom." In a previous part of the report, at folio 92, are found the following apposite remarks, which scarcely appear to have emanated from the same mind:—"The continuous removal of impure air, as it arises, is of very much greater importance than the cubical contents of air in a room. In the soldiers' rooms, which are constantly occupied, the amount of cubical space can be of very little importance, for how lofty soever the rooms may be, unless the heated and impure air can pass away, the space will soon be occupied by air unfit for respiration, and the greater or the less size of the room will only resolve itself into a little more or a little less time before the air is brought into an impure condition." "The soldiers' rooms are about 12 feet in height; with good ventilation, this might be reduced to 11 feet or even to 10 feet without disadvantage."

700 cubic feet per person ;" another in a publication by Dr. Drutt, entitled "The Health of the Parish," where it is said that "It has been decided at Bow-street that every inmate of a family ought to have 400 cubic feet of space." On inquiring at Bow-street as to the latter decision, I learned that the magistrates have no power to determine the space, and was referred to the Assistant Commissioner of Police, who informed me "that 30 feet superficial is the space allowed to each lodger in the metropolitan common lodging-houses, the rooms averaging 8 feet high, which is equal to 240 feet cube, and that 50 feet superficial is allowed to each police-constable lodged in a station or section-house, the rooms on an average being 9 feet high," which is equal to 450 cubic feet. The Poor Law Board, without laying down any fixed rule applicable to all circumstances, adopts as a basis of calculation an allowance of 500 cubic feet for every person in sick wards,* and 300 cubic feet for every healthy person in the dormitories. The Sanitary Inspector in Dublin requires in registered lodging-houses an allowance of 308 cubic feet to each person.

Dwellings for all classes of persons, in order to their being healthy, should be so constructed as that they will be *everywhere accessible to pure air*, and be free from stagnation in any part; and, whilst it is obvious that the state of the surrounding air must have much influence on that within the dwelling, the renewal of the latter should always be sought from the purest source, instead of the supply being drawn, as it often is, from a low damp situation or a confined internal court.

Considered practically, the *main question* with regard to ventilation is, in what way the air which has become vitiated can be renewed with a supply of pure fresh air, without the creation of a draught injurious to health! To do this the air must enter copiously, and almost imperceptibly, and when used, or become vitiated, its exit should be both continuous and complete.

Ventilation is of two kinds, *natural and artificial*; the former being effected by means of windows and doors, with the crevices round them, as well as by chimneys and fireplaces, which are important agents in natural ventilation, and may also, by scientific arrangements, be made conducive to an efficient system of artificial ventilation, peculiarly applicable to dwelling-houses.

In new buildings improvements may be easily adopted which are not always applicable to old buildings; but, as far as circumstances allow, they should be carried out, from a settled conviction that pure air is indispensable to a healthy state both of body and mind.

* In order that the amount of space now deemed requisite in hospitals may be readily compared with the above, I quote the following:—"In solid-built hospitals the progress of the cases will betray any curtailment of space much below 1500 cubic feet. In Paris 1700, and in London 2000, and even 2500 cubic feet, are now thought advisable."—Miss Nightingale's "Notes on the Sanitary Condition of Hospitals."

Windows properly constructed, made to open at the top as well as below, and suitably placed, afford the most ready means for the natural ventilation of dwellings, besides which are the various contrivances of louvres, of perforated glass, zinc, tin, &c.

Chimneys act as ventilators whenever a fire is lighted in a room: the lower stratum of air being immediately set in movement, a current of air is established from the crevices round the doors and windows, or from any other openings towards the chimney, whereby much of the vitiated air is carried off. This process of ventilation takes place in a slight degree when there is no fire in the chimney, and therefore bed-rooms are much more healthy with a chimney than without. It should not, however, be forgotten that a large portion of the vitiated air ascends above the chimney opening, and therefore it is essential that a provision be made for its removal thence, whenever perfect ventilation is desired.

An independent supply of fresh air may be introduced into most rooms which have a fireplace, by conveying it through a pipe or channel formed under the floor, or in the wall, to an air-chamber constructed at the back or sides of the stove, in order that it should be there warmed before entering the room. I have seen in Edinburgh a solid fire-clay bed-room chimney-piece and grate so formed as to leave, when it is set, a cavity round it, which appears well adapted for this purpose. The same, or a separate pipe or channel may also be used for feeding the fire with air, independent of that in the room; for this purpose it should pass out at the cheeks of the stove, rather than beneath the grate, which is liable to cause a diffusion of dust in the room.

Chimney ventilating valves are rendered, by such a supply of air, more certain in their action than they often prove to be, owing generally to an insufficient draught in the chimney, which causes the emission of smoke into the room. These valves would be invaluable for the discharge of vitiated air, which is their intended purpose, were it not for this occasional ingress of smoke. The most effective means of avoiding that evil is the carrying up an independent flue in close contact with a smoke flue, constantly in use, as that from the kitchen, the air within the ventilating flue is by this means rarefied, and the action of the valve rendered more efficient. Tubular flues, of pottery, made double for this express purpose, are found to answer well, and have the advantage of occupying but little space, whilst they are not liable to the objection pointed out to me many years since by an eminent builder who had found that cast-iron flue linings, having no mortar joints, acted as a dead shore in the wall. In cases where the chimney-valve, being fixed in the flue, causes an ingress of smoke, the most effectual remedy is, I believe, Dr. Arnott's smokeless grate, with the draught duly regulated by a contraction of the vacant space over the fire. These grates economize fuel considerably.

Ordinary grates, I may here remark, are alike wasteful of heat and fuel, both of which would be much economized by the substi-

tution of a stove projecting slightly into the room, and combining the chief advantages of the one known as Dr. Arnott's ventilating stove, with the cheerful open fireplace. I have seen some such stoves in use on the Continent, and I believe that the only valid reason against their adoption in England, beyond the force of custom, is the difficulty—not, however, an insurmountable one—of applying them to fireplaces with the ornamental chimney-pieces in such general use. One of the most useful modern improvements in grates is that of forming the back and linings with fire-brick instead of iron.

The intimate connexion between warming and ventilation has led to a digression, in returning from which I remark that, in order to render natural ventilation effectual, the openings required for the escape of vitiated air should be placed either in the ceiling or near to it.* How far the admission of fresh air also in the upper part of the room be objectionable, on the ground that the air vitiated by breathing, which ascends in consequence of its relative lightness, is in that case only *diluted*, and not entirely replaced by pure air, remains, I believe, yet to be determined by properly conducted experiments.

It would be a vain attempt to point out the most suitable situation, or even the level at which, under all circumstances, fresh air should be admitted. The point of greatest importance is the avoidance of a perceptible current or draught; and wherever that can be combined with the admission of a sufficient volume of pure air, there it may be allowed to enter. In some situations this may be near the floor, or a little above it, in others an arrangement suitable for the purpose may be made by fixing a hopper or a sliding ventilator over the door,† or in the upper part of it. A plan often applicable to bed-rooms, where good ventilation is so essential, though lamentably neglected. In small rooms with a fireplace, this addition to the usual means of changing the air, generally suffices to keep them in a healthy state; but where there is no fireplace there should be a distinct provision for the escape of the vitiated air, which may sometimes be effected by means of a pipe carried through the roof and bent on the top. It should be remembered that

* In a certain description of common rooms, ventilation may be effected by means of wooden tubes perforated with holes, or having chinks at the angles: in some cases they may be carried across the ceilings, and in others be fixed at the angles. They have also been used for admitting fresh air as well as for the exit of vitiated air. These tubes distribute the air more generally, and are not so likely to be closed as either Sherrington's or Hart's Ventilators, both of which are very useful in many situations. A cheap cottage ventilator may be made with a triangular piece of zinc, fixed in an upper angle of a window, and perforated in the centre, with a projecting rim formed round the perforated part, in order to receive a movable cover, which may be hinged.

† If arrangements were made for this purpose in the construction of new buildings, much benefit might be derived therefrom.

where openings can be formed on the opposite sides of rooms, the air will be most speedily and effectually changed.

With all the various contrivances and arrangements proposed for the admission of fresh, and the exit of vitiated air, unaided by those appliances which are scarcely consistent with the term *natural ventilation*, none have come under my observation which secure uniform action, and fully guarantee that the distinct provision made for the exit of vitiated air shall not become the medium for the ingress of cold air, on a change of temperature in the apartment, the frequent consequence of which is a draught, more or less perceptible. In order to avoid this evil, various means have been adopted, according to circumstances, with varying success. The use made of chimney-shafts for this purpose has been already noticed. Tubes or shafts, of wood, of clay, or of metal, are also available, provided a constant outward current is maintained by such an application of heat as will sufficiently rarefy the air. Hot water has often been applied externally for this purpose with advantage. I have used gas enclosed within an upright shaft, partly of wood, the light being placed behind a square of glass, and the air entering through perforated zinc, with a hopper enclosure; by these means the combined benefits of light and ventilation are obtained from the same quarter. In many situations this simple plan might be easily adopted, and in dwelling-houses generally I believe that gas might frequently be rendered a valuable contributor to ventilation, instead of being injurious to health. As a sunlight, with a double tube, it has been so employed in public buildings with success.

The utilisation of heat from stove fires, from hot water, or from gas in ordinary use about a house, is apparently so natural and easy a means of obtaining a motive power to assist in the ventilation of dwelling-houses, that I have noticed them under the head of *natural*, rather than of *artificial* ventilation, to which I must now refer.

Artificial ventilation is ordinarily effected by the action of valves, fans, pumps, screws, furnaces, stoves, or other artificial heat, and a variety of contrivances whereby air is either drawn out of, or forced into an apartment. In the one case, the space occupied by the vitiated air withdrawn, is replaced by an admission of pure fresh air; and in the other the pure air forced into the apartment causes a displacement of the vitiated air, for the escape of which due provision must be made. In both cases a just proportion between the volume of air which ought to enter, and that which should be expelled is necessary. In order that the fresh air may be adapted for use at all seasons of the year, means must be provided for warming it prior to its distribution in the apartment. The best means for effecting this is, I believe, by bringing it in contact with heated fire-brick, suitably arranged in stoves or furnaces. When heated iron is used for this purpose the air is liable to be deteriorated, or, as is commonly said, burnt.

Hot water, which is similarly employed, has not this injurious effect.

Whether suction or propulsion be preferable as a motive power for effecting the change of air in ventilation, is a question which has been much discussed here, as well as in Paris and Brussels. After examining both systems in their practical application, the latter appears to me decidedly preferable, excepting in peculiar cases, when the power of suction may be more readily applied.

When fresh air is forced into an apartment, through suitably placed openings, it becomes more generally diffused than it does when its entrance is dependent on the withdrawal of the vitiated air by means of suction, the tendency of which is to draw the fresh air towards the point of exit, instead of leaving it to disperse and circulate freely. Suction involves the further disadvantage of setting in movement whatever noxious vapours may be within its reach.

Nothing can be more inconsistent with a healthy system of warming than those arrangements which provide only for raising the temperature of the air already in the apartment, vitiated as it may be. Such is mostly the case when the German hot-air stove is used, and also when hot water is circulated in pipes through the apartments; but either may be employed with impunity as an auxiliary to an open fire.

Whilst artificial ventilation is mainly applicable to public buildings, to manufactories, and to dwelling-houses of considerable magnitude, its principles may often be adopted in ordinary instances occurring in an architect's practice.

For this reason, as well as on account of the great influence which ventilation exercises on health, more has been said on this branch of my subject than some may consider necessary. I cannot, however, quit it without expressing a regret that the science of ventilation* has not been more thoroughly mastered and its practical application more simplified than it would seem to be from the Report of the Government Commissioners on Warming and Ventilation, known doubtless to many of you, and which, with its mass of practical information appears to me to have failed in placing the subject in that clear light which was contemplated in the suggestions made by Dr. N. Arnott, in 1849, for an investigation by "a committee of eminent scientific men, comprising chemists, engineers, and physicians."

Thirdly.—THE CIRCUMSTANCES WHICH DEPEND MAINLY, THOUGH NOT WHOLLY, ON THE OCCUPANTS THEMSELVES—external and internal cleanliness, and a proper use of structural arrangements—remain to be briefly noticed.

The most suitable provision for rendering a dwelling dry, or for its efficient ventilation, will not secure the health of the occupants

* A simple test, whereby the deterioration of the air could be readily ascertained, is a great desideratum.

if those provisions are not properly used, or if there be around or within the abode an accumulation of dirt, whether in a solid or in a liquid state. Houses may, to all appearance, be very desirable dwellings, but if the drainage be out of order, or there be cesspools within their precincts, or untrapped and foul sinks, there is no safety for the inmates. Nor can the close proximity of stables be a matter of such indifference as might be supposed from the practice so prevalent in the most wealthy parts of the metropolis; for one inevitable consequence is that, in the summer, many windows which should be opened for ventilation remain closed, in order to exclude the noxious fumes of the dunghesps.

Neglect of sanitary laws is as much manifested in the country as it is in towns, and on the Continent not less than it is in England. It would be easy to point to spots where the air is untrapped for purity, and the scenery around surpassing beauty; and yet such are the accumulations about the dwellings, that it is often difficult to enter the doors without wading through a stream of filth, alike offensive to the sight and to the smell. Can it be a matter of surprise if such violations of the known laws by which God regulates the health of his creatures, be visited with sickness and premature death? With equal certainty as to the issue, we may predict that those who live in close proximity to black and stagnant pools, to foul ditches, or to sluggish open drains, will periodically suffer from fever or dysentery, as we do that the house in flames will be consumed if the destructive element be not extinguished, or that the neglected garden will be overrun with weeds and become a wilderness.

Internal cleanliness in the houses of the *scavally*, and all that as matters of daily routine are connected therewith, including proper attention to the sinks and traps, as well as the ventilation generally, is, in the main, left to the care of servants; and often through their ignorance, rather than their culpable neglect, the health of the family, and especially that of the younger children, is very seriously injured, without the slightest apprehension as to the cause. Many instances might be cited in proof of a fact which is calculated to arouse even the most self-indulgent, and to induce them to co-operate in such a diffusion of sanitary knowledge as will alone insure, that which is dependent on the occupants themselves, a proper use of the structural arrangements essential to a healthy dwelling. Disease may often be communicated to the wealthy through the medium of articles of clothing made in unhealthy dwellings, a fact which, if it were more palpable, might lead even the most selfish to consider their personal interest in the sanitary condition of the houses of working people.

* The recent publication in a cheap form of Miss Nightingale's highly practical "Notes on Nursing" affords the means of conveying many valuable lessons on this subject to domestic servants. I have endeavoured to give some practical instruction of a more general character, in a lecture entitled "Home Reform; or, What the Working Classes may do to improve their own Dwellings."

The middle classes would contribute less grudgingly than they frequently do, towards the cost of public sanitary improvements, and would even urge their extension, if they were better acquainted with the laws of health and the heavy expenses which their infringement often involves on the community, as well as on individuals; whilst a practical knowledge of those relating to in-door life—whether it be that of the dwelling-house, the manufactory, or the workshop—would lead them duly to appreciate the advantages of cleanliness and good ventilation, and to see that their benefits were extended more generally to those hives of human industry where numbers of working people congregate for many successive hours, partly under the deleterious influence of gas light.

If the want of knowledge and forethought debar many in the upper and middle walks of life the full enjoyment of a healthy dwelling, how much more is it the case in regard to the *labouring population*, most of whom are under the further disadvantage of having scarcely any choice as to the external circumstances of their dwellings, and often but little as to the internal accommodation. The difficulties arising therefrom, which working people have to contend with in most thickly populated towns, are well known to be very great. I shall not dwell upon them here, nor attempt to point out the degree in which they are increased by habits of intemperance—the most fruitful cause as well as consequence of domestic wretchedness. Such a calculation as would show the probable amount expended by the working population in the metropolis and its suburbs in the 10,200 houses open for the retail sale of intoxicating liquors would be instructive, not only as to one fruitful cause of the evil, but also as to legislative measures, of an indirect character, needed for its removal.

Some of the benefits resulting from the efforts made for supplying healthy dwellings for the working classes may be judged of by a single quotation from an Official Report laid before Parliament. It refers to the houses built in Cowley-street, Shadwell. *Vol.* p. 38:—

“The erection of these Albert cottages, provided with arrangements essential to health, comfort, and morals, is producing the happiest results in the neighbourhood. Tenants have become sensible of the discomforts and evils of their unwholesome dwellings, and will not remain in, or take houses, without many improvements which formerly they were content to do without, and landlords are finding it to their interest to improve their old houses; and in constructing new ones to provide superior accommodation and conveniences.”

Those who now appreciate but little, if at all, that which is so essential to their wellbeing, may, by such means as these, be practically taught the value of a healthy dwelling.

THE Second branch of the Subject now to be considered is
—The Extension of the Benefits of a Healthy Dwelling
to the Labouring Population.

The numerous discussions bearing on this question which have taken place in Parliament, in the daily papers, as well as in other periodicals and pamphlets, might lead to the supposition that its importance is now duly estimated by the public; but those who have sounded the depth and scanned the wide-spread extent of the evil to be remedied, well know that such is not the case, and have too often seen the responsibility of contributing to its removal ignored by those who ought to feel its weight; whilst in some deeply to be regretted instances, the want of a due estimate of the difficulties to be overcome, and of the requisite practical knowledge, has led to the pursuit of measures which, owing to their non-remunerative pecuniary results, have tended seriously to retard the progress of a movement, practically commenced eighteen years since.

The pecuniary features of the question are of such vital importance, from their necessary bearing on the adequate extension of the work, that I cannot here omit the expression of my belief that if the actual expenditure in providing improved dwellings for the labouring classes in towns had more generally been managed with such discretion as to yield the very moderate return of 4 per cent. or even of 3½ per cent., after the payment of all expenses and the providing a sinking fund for the repayment of the money laid out, there would have been no difficulty in obtaining from philanthropic capitalists an amount sufficient for building a very large number of improved dwellings, in the metropolis, as well as in our provincial towns; and in evidence that such a return is obtainable numerous examples might be instanced of that and a higher rate of interest on the outlay having been regularly obtained. Whilst some of these will be noticed hereafter, I think it right to remark, in reference to certain exceptional cases, that due allowance should be made for the difficulties and extra expenses attendant on most new undertakings, as well as for the experimental nature of some of the establishments in which the accommodation provided has been of a very mixed character. The results in those instances show, I believe, invariably, that new houses for families yield a better return on the outlay than lodging-houses for single persons, a purpose to which, however, old buildings have been adapted with very satisfactory pecuniary results.

Speculative builders, or those who are merely seeking what is usually called a good investment, would not, of course, consider 4 per cent. a sufficiently remunerative return; but I confess to feeling some surprise that, amongst the many who have accumulated

large fortunes in connexion with the building trade in the metropolis, I know of only one firm, that of Messrs. Newson and Son, having so invested a part of the gains derived, in a large measure, from the labour of the working classes. It may, however, be owing to my limited means of information in this respect that I am unable to name other instances in the metropolis, though in Edinburgh several such examples were lately pointed out to me, which I could not but regard with peculiar interest and as well worthy of imitation. Some notice of these buildings is given in my report made at the Glasgow meeting for the Promotion of Social Science. I have also seen with pleasure, in a very useful monthly paper, the *British Workman*, which circulates extensively amongst that class of readers, a view and brief notice of a village near Lowestoft, rebuilt by Sir Morton Peto, which is described as one of the most picturesque villages in the kingdom.

Architects have sometimes been reproached for a want of interest and for exercising so little influence in regard to the improvement of the dwellings of the labouring classes. Knowing, as I well do, how rarely the members of the profession* have to do with buildings of this class, such a charge is to me only one amongst many other proofs of the prevailing ignorance with regard to the measures and machinery best adapted to remedy the evil in question, and which I shall endeavour, as far as my ability and experience enable me, to point out, unbiassed by any interest whatever, and only actuated by the earnest desire of contributing to an object which I believe is most intimately connected with the physical, the moral, and the religious improvement of the masses of our population.

The measures for effecting this much-needed reform may be classified under three heads:—

1. Those of a legislative character, and those for which the Executive Government are responsible.
2. Those which ought to be adopted by landowners and employers generally for the benefit of their dependents, whether as tenants or workpeople constantly employed by them.
3. Those which originate from benevolent motives, and are undertaken either by associations or by individuals, in order to aid those in helping themselves who need such aid.

In noticing successively these three classes of measures, some illustrative facts will be stated, which are partially the results of observations made during a residence of nearly five years on the

* My long and highly-esteemed friends, Mr. Sydney Smirke and Mr. G. Gilbert Scott, have manifested, in their published works, a warm interest in this object; the former, in his "Suggestions for the Improvement of the Western Part of the Metropolis," published in 1834,—and the latter in his "Remarks on Secular and Domestic Architecture,"—expatiate on its importance, and propose practical measures; whilst the voice and pen of Mr. George Godwin have not only been exercised unceasingly for its advancement, but often also in vindicating the position and feelings of the members of his profession with regard to the question generally.

Continent for the recovery of health. Some of the investigations then made lead me to remark, in reference to the first class of measures, that a jealous respect for the rights of persons and property, which is our security for many of the inestimable advantages enjoyed under a free government, has a manifest tendency to impede the carrying out of such public improvements as those which, under arbitrary rule, have been effected with unprecedented rapidity, on so gigantic a scale, in the metropolis of a neighbouring country. What I think, in our own metropolis, we have a right to complain of, and ought to feel ashamed at, is the bungling and pettifogging manner in which many of our new streets have been formed, and fine opportunities for obtaining magnificent effects irrecoverably lost. It would be invidious to point them out; they will readily suggest themselves to you.

Time will not allow me to dwell on the important bearing which the formation of new streets has on this subject, or many facts which have come under my own observation might be stated, particularly some with regard to that great financial failure, Victoria-street, where several fruitless attempts were made to obtain from the managers, on reasonable terms, back land, as sites adapted for dwellings suited to the displaced population, who, as a necessary consequence of the clearance which had been made, were huddled together in a frightful degree. This is but one example of what has so frequently taken place elsewhere in our own metropolis, owing to the want of a compulsory provision for the displaced poor.

The same neglect on the part of the Government was the cause of an incalculable amount of suffering in Paris, when the people who tenanted its narrow and winding streets were forcibly ejected, and often their few articles of furniture placed on the pavé, they themselves not knowing where to seek shelter. I visited more than once, in the spring of 1858, a kind of encampment of 600 such families, formed not far from the *Barrière de l'Etoile*, and heard from some of them their pitiable tale, and the exorbitant rent they were paying for temporary hovels, which the police had warned them would be pulled down in three months, and they forced again to go they knew not whither. From a sense of duty, and encouraged by the fact of the Emperor having caused the paper which I read before the Institute in 1850 to be translated and widely circulated in France, I thought it right to bring this subject under his Majesty's personal consideration, in a memorial, which was graciously received, and I hope, has not been altogether fruitless.

Our own legislative measures tending to give to the labouring population the benefits of a healthy dwelling, only comprised, when I addressed the Institute twelve years since, the passing of the Public Health Act, and the Nuisance Removal and Diseases Prevention Acts. Since then several measures, the necessity for which was dwelt upon in my paper, have been adopted, such as the removal of the tax on windows and on bricks, for both of which we

are indebted to the Administration under Lord John, now the Earl Russell; the act for the regulation of common lodging-houses (one of the most, amongst the many, valuable efforts of the Earl of Shaftesbury in this cause); the empowering, under the Labourers' Dwelling Act, the formation and general management of independent local Associations, formed for providing improved dwellings, on the principle of joint-stock companies, with limited liability. Other bills have been passed for facilitating the construction of improved labourers' dwellings and cottages in Scotland and in Ireland.

During the last session, a bill which would have given to English landowners, tenants in tail, the power of raising money for building improved cottages on their estates, very similar to that already granted in Scotland, was, after it had passed the House of Commons with but little opposition, rejected by a majority of 16 to 13 in the House of Lords. The debate on this occasion had at least the appearance of showing how much less real interest is taken in this question than might have been inferred from several debates, at the opening of the session, relative to the destruction of labourers' dwellings, in consequence of the introduction of railways to the centre of the metropolis. Those debates led to the insertion of clauses in some of the railway bills obliging the companies to provide certain cheap trains, at hours suitable for the conveyance of working people to and from the precincts of their residences out of town. A standing order, intended to apply to cases in which application is made to Parliament for power to pull down houses occupied by the working population, was passed by the House of Lords in 1853, at the instigation of the Earl of Shaftesbury, but, as far as practical results, it had become a dead letter.

That further legislative interference is indispensable to the remedying existing evils might be proved by abundant evidence. Excepting within the city of London,* and in the case of common lodging-houses, no power has yet been granted effectually to check the evil of overcrowding, in regard to which the Medical Officer of Health in the city of London thus speaks:—"Without doubt, it is the worst of all the unwholesome influences with which you have to deal; and until it is corrected you will never be secure from those outbursts of disease which appear to set your sanitary measures at defiance." A report made by the Assistant-Commissioner of Police on the condition of single rooms occupied by families in the metropolis, without the precincts of the city authorities, after giving in detail about forty most painfully disgusting examples of overcrowding, says:—"It is evident from these cases, which might be greatly multiplied, that all the evils which the Acts for regulating common lodging-houses were intended to remedy still exist, almost without

* The power referred to was conferred in 1851, and under the supervision of the able medical officer of health it is exercised with great benefit to the poor, as a diminution in the returns of mortality from 25 to 23 in 1900, traceable to this and other sanitary measures, abundantly proves.

abatement, in single rooms occupied by families, single rooms so occupied being exempt from the operation of the Act." "The causes are the avarice of owners, and the poverty or debasement of occupants, and the only hope of improvement seems to be in some legislative enactment."

In regard to the overcrowding of cottages in country districts, I might remind you of the numerous letters on that subject which not long since appeared in the *Times*,† and were but the echo of what has been said and proved so often elsewhere. It was with a view to obtain reliable statistical returns on this important subject that about eighteen months since the then Secretary of State for the Home Department was memorialized, and urged by a deputation from the Council of the National Association for Social Science, to take advantage of the recent Census for this purpose; but, notwithstanding that the unobjectionable character of the inquiry, and the ease with which it could be made, were fully admitted, the application proved fruitless.

After all that has been done within the past fifteen years by many proprietors in providing improved cottages on their estates, there are yet numbers who need to be made aware of facts which exist on their own property,‡ and there is reason to fear that, with regard to others, their obligations must be pressed home in such a way as they doubtless would be were the Registrar-General enabled to instance flagrant cases of neglect, and to show what the results are by unquestionable facts. I cannot help, therefore, regarding the loss of this opportunity as a matter for very serious regret, especially when it is remembered how little the Government can do directly towards the domiciliary reform so greatly needed amongst the masses of the population.

By legislative enactments can alone be prevented the recurrence of those hardships and other great evils which have arisen out of the selfish system pursued in some "*close parishes*," where cottages have been pulled down in order to obtain relief from a burthen which is thereby thrown upon a neighbouring parish, regardless of the sufferings endured by the labourer, who is often, as a consequence, compelled to walk several miles to and from his work. A calculation of the positive loss from the waste of valuable time and strength thus expended was made by the late Sir Robert Peel; and

* The writer of one of these letters, "A Berkshire Magistrate," in a note to me lately, says, "I am constrained to confess that from all I see and hear, unless the Government take up the question honestly and fully, little or nothing will be done to remedy evils which are so fearfully apparent. I brought the matter forward at a full attendance of magistrates in Berkshire last week, and of all the influential persons present, influential especially as regards this momentous question, not one seconded my motion."

† A system of registration of the actual conditions and extent of accommodation in existing cottages has been suggested by Dr. H. Arland, of Oxford, which, if generally adopted by proprietors, would doubtless elicit some very startling facts. Mr. Parker, of Oxford, will supply these forms of registration on the receipt of a postage-stamp.

yet, how many who have labourers in their constant employ need to be convinced that it is as much their interest to care for them in regard to their dwellings, as it is to provide well situated, healthy, and convenient stables for their cattle?

An amendment of the laws relating to the Transfer of Land would in no small degree facilitate the providing improved cottages, and enable the working classes more easily to become the owners of their own dwellings, an object which has proved in England as well as on the Continent, a very powerful stimulant to forethought and general good conduct.

The only other legislative measure which I shall point out as being especially needed, is one that would operate generally to prevent the building of small houses on undrained ground, and without proper sanitary arrangements. Such a fruitful source of sickness and consequent expense to the public ought, without doubt, to be entirely interdicted; it is an evil, the extent or the magnitude of which, it would be difficult to estimate with accuracy.

As bearing on this and several other points which have been referred to, I may quote the words used two years since by a right hon. gentleman, the present First Commissioner of Works—"As yet the necessity of protecting life from the influence of poisonous dwellings has not practically been acknowledged, though the principle is in the statute book."

It is unnecessary to occupy your time at any length with that which has been done for the object under consideration by the Governments of other countries, where, in numerous instances, our example has been attentively watched, if not followed. In some of these cases I have had the pleasure of tracing the results of my own labours in this cause, abroad as well as at home, rendered in the former mainly through personal intercourse, and the circulation of translated papers.

2. In noticing the measures which ought to be adopted by *land-owners and employers generally* for the benefit of their dependents, such as tenants, or workpeople in their constant employ, I feel that a quotation from the letter of the late Duke of Bedford, given at length in my former paper, is the best reply which can be made to the excuses of many for their neglect of duty in this respect:—"Cottage building, except to a cottage speculator, who exacts immoderate rents for scanty and defective habitations, is, we all know, a bad investment of money; but this is not the light in which such a subject should be viewed by landlords, from whom it is surely not too much to expect that whilst they are building and improving farmhouses, homesteads, and cattle sheds, they will also build and improve dwellings for their labourers in sufficient number to meet the improved and improving cultivation of the land. To improve the dwellings of the labouring classes, and afford them the means of greater cleanliness, health, and comfort in their own homes; to extend education, and thus raise the social and moral habits of those most valuable members of the community,

are among the first duties, and ought to be among the truest pleasures, of every landlord."

The example which was set by his Grace in the building and improving the cottages on his estates in seven different counties involved, in the course of eight or ten years, an outlay of about 70,000*l.* Another instance of princely expenditure on the same object is that of the Duke of Northumberland, which has been estimated at 100,000*l.* The average cost of the cottages built by these two noblemen may be stated at from 90*l.* to 120*l.* each.

The question of a *remunerative return* on the outlay in building cottages in agricultural districts, is one which impinges so closely on that of the rate of wages, that I shall not venture on its discussion. It would be hopeless to argue this point with those who think that wages of 8*s.* to 9*s.* per week can properly maintain a working man and his family, as well as pay the rent of a healthy dwelling. With the greatly increased prosperity of agriculture, such a rate of wages appears to me unaccountable, and altogether at variance with equity and sound policy.

The efforts made by some of our great manufacturers for the benefit of their workpeople have been in proportion to those just noticed. Many owners of mines, quarries, and works of various kinds, can bear testimony to the great benefits resulting from their expenditure in providing proper dwellings for the people in their employ.

The same has been the case with reference to the cottages built in considerable numbers by several of the leading railway companies.* The secretaries of some of them, in speaking on the subject, have referred particularly to the great advantage of having the men ready at hand, in case of need, and removed from the temptation presented by public-houses. Government has acted on the same principle in regard to the Police force, and, taking the idea originally from the model lodging-houses, barracks have been built generally for those of them who are unmarried—a good precedent, which might doubtless be adopted in many other instances with much advantage to both employers and employed. In such cases a sufficiently remunerative rent can usually be charged, and its payment be guaranteed by a deduction from the wages.

A lodging-house, established at Camden-town in 1834, by Messrs. Fickford and Co., the well-known carriers, for the unmarried men in their employ, has now 60 inmates; the payment of 2*s.* 6*d.* per week by the men, and 1*s.* 6*d.* by small boys, covers all expenses and the interest on the outlay, whilst there is "a great improvement in the men as regards orderly conduct, cleanliness, &c." When visiting this house I noticed a common carter copying a piece of music.

* The Great Northern Railway Company has built 150 cottages at their station, near Peterborough, and the Brighton Company has built and acquired nearly 400 cottages for their men.

On the *Continent*, our example has in this respect been much followed. At the Paris Exhibition, 1855, there were many views of workmen's dwellings erected by their employers. In two of them particularly, the leading features of the Prince Consort's Exhibition Model Houses were strongly marked. One, constructed in 1853, at Bourges, provides accommodation for four families on the ground floor, and for twenty single men on the upper floor. The other is that of the *Cité Ouvrière des Verriers*, at Escoutpont, near Valenciennes, which comprises, in a central building, schools and other apartments used in common, with some of the dwelling-houses, but the latter are chiefly contained in two detached blocks, forming the sides of a hollow square. In these buildings the frequent repetition of recessed entrances, with galleries to the upper floor, is, from the contrast of light and shade, productive of a novel and good effect.

I have visited dwellings for workpeople built by their employers in Brussels, at Liale, and also at Mulhouse, one of the chief manufacturing places in France, where the idea of constructing a *Cité Ouvrière* originated in the receipt of a translation of my former lecture, sent by order of the Emperor. It was commenced in 1853, by an association of manufacturers, headed by M. Jean Dollfus, on a scale more extensive and complete than that of any similar establishment in France. A spacious road, planted on either side, runs between the main groups of cottages, and parallel roads run behind them. The houses are chiefly arranged in detached blocks of four dwellings each, placed in the centre of a square plot of garden ground, which is divided equally between the tenants; two of these dwellings front the main central road, and two the minor or back road—an economical arrangement in regard to cost of construction, and one which admits of good internal ventilation, though not as perfect as when houses are built in pairs. The dwellings, though not precisely uniform in their disposition, have mostly a wide entrance, fitted up with a cooking-stove and sink; beyond is a staircase, leading to three bed-rooms and a closet. The remainder of the ground floor is devoted to the living-room, with a large recess behind the staircase, of sufficient dimensions to contain a full-sized bed; this compartment has a side window, and, in some cases, being partitioned off from the living-room, it forms a small separate room. There are, besides these, several rows of double houses, built back to back, each having a narrow strip of garden-ground; their arrangement cannot be commended as consistent with good ventilation, and the general appearance of the tenants indicated a decidedly inferior class of occupants. Baths, a washhouse, and a bakehouse, as well as a public kitchen and *restaurant*, conducted by a *Société Alimentaire*, were opened when I visited the *cité* in 1856; since which have been added a reading-room, a school, a lodging-house for unmarried men, and one for men on the tramp.

In the summer of 1860 there were completed 480 houses, two-thirds of which had been sold to the occupiers, and 90 more were

in the course of construction, land having been bought for 800 in the whole.

The outlay on the roads, fencing and planting, was defrayed out of a Government subvention of 300,000 francs, or 12,000*l.*; being a part of 10,000,000 francs appropriated to such purposes by the Emperor, with a view to stimulate the work in France. The tenants have the option of purchasing the houses by the gradual payment of their cost price, which ranges from 72*l.* to 120*l.* each, and two-thirds of them have done so, to the very marked benefit of themselves and families, and with the further good result of providing the funds necessary for continuing the buildings, without increase of capital on the part of the projectors, to whom, as well as to M. Emile Muller, of Paris, under whose direction they were built, the greatest credit is due.

I have thought that these details may be useful, and perhaps suggestive, with reference to schemes often projected for building workmen's dwellings in large numbers out of our own metropolis, with a view to their occupants being conveyed to and fro by cheap railway trains. With the same object I notice having seen near Paris an entire village, then all but completed, which had been built by a Parisian tailor for his workpeople. It comprises wooden houses, or chalets, for 76 families, 23 intended for single, and 48 for groups of families, each occupying a separate tenement, and having two, three, or four rooms. There are two spacious workshops, and although some defects might easily be pointed out, an air of neatness and order gives the whole a very pleasing effect. Here the work, which is sold in the very heart of the city, and has hitherto been done by workmen residing with their families in miserable, unhealthy, and at the same time high-rented dwellings, will be done under the advantage of abundant light and pure air, greatly to the advantage of the consumer, the employer, and the employed, as well as of the pockets of those who have generally to bear the burden of supporting the working man and his dependents in case of sickness.

It would be easy for me to illustrate by many other examples, at home and abroad, the practical recognition by those who have working people in their regular and exclusive employ, of an obligation to see that they are properly housed, and at the same time to show the benefits resulting therefrom to both parties. But other measures have yet to be noticed, which will be grouped under the last head, viz.—

3. The measures which originate from benevolent motives, and are undertaken either by *associations* or by *individuals*, in order to aid those in helping themselves who need such aid.

My former paper recited the establishment by philanthropic individuals of two associations, one of which commenced in 1844 and the other in 1845, the building of improved or model dwellings for the working classes in the metropolis. Highly beneficial as these societies have unquestionably been in the pioneering work of this

movement, experience has, in regard to one of them, confirmed the opinion I held when undertaking, in 1844, the duties of its honorary architect, that it should aim at doing a little and doing it well, so as to be in deed, and not in name only, a model society, rather than attempt more than from its constitution it could be reasonably expected to accomplish, with such results as would commend it for imitation. The society to which I refer is that for Improving the Condition of the Labouring Classes, which has constructed under my direction four distinct ranges of new buildings, accommodating 97 families in separate dwellings, and providing 94 rooms for single women, as well as lodgings for 104 single men, and a public washhouse with baths. Whilst in three distinct localities, old houses were renovated and fitted to provide lodging for 138 single men. The expenditure on these several dwellings and lodging-houses has been about 36,500*l.*, and they have all been in full occupation since 1852.* Subsequent to my going on the Continent, in 1853, three entire courts in different localities were taken, and the condition of the houses in two of them, which were indescribably filthy, and occupied by the lowest class of tenants, was completely changed. The number of rooms collectively contained in these courts is 275, and there is also a single men's lodging-house with 40 beds. The total outlay on these three courts has been 7,226*l.* 1*s.* 4*d.*, and the net return for the year 1859, after

* The receipts and expenses of four of these different buildings during the year 1852, for which I can personally speak to the management of the Society, having then acted on its Committee and as its honorary architect, were:—

Bagnigge-wells: self-contained houses and flats for 22 families, and rooms for 30 aged females. Outlay on land, 1045 <i>l.</i> ; building, 5925 <i>l.</i>	Receipts	£375 7 7
	Expenses	82 6 9
	Net Return	293 0 10
Stratham-street: houses for 54 families, built on flats, fire-proof, and with galleries. Outlay, ground-rent, 50 <i>l.</i> ; building, 5916 <i>l.</i> 16 <i>s.</i>	Receipts	224 7 4
	Expenses	224 15 1
	Net Return	499 9 3
George-street: lodging-house for 104 men, six stories high, including basement offices, and four floors of dormitories. Outlay, land, 1200 <i>l.</i> ; building, 5226 <i>l.</i>	Receipts	618 11 4
	Expenses	305 6 2
	Net Return	312 5 2
Charles-street: lodging-house for 84 men formed out of three old houses, renovated and thrown into one. Outlay on repairs and furniture, 1163 <i>l.</i> 1 <i>s.</i> 2 <i>d.</i>	Receipts	418 0 4
	Expenses	233 5 2
	Net Return	184 15 2

The rents received from these houses have varied but slightly since they were opened up to the present time, and they are generally well filled, the families changing but seldom. The cost of repairs is not included in the expenses above stated; they should be taken as averaging 1 per cent. on new, and generally from 1 to 2 per cent. on old buildings.

deducting all expenses and repairs, was 249*l.* 18*s.* 11*d.*, or 3½ per cent.;* whilst from the Society's new building in Stratham-street for 54 families, where the expenditure was 8,916*l.* 16*s.*, the corresponding net return for the same year was 420*l.* 18*s.* 8*d.*, or 4½ per cent. on the outlay, and from the model lodging-house for men in George-street, St. Giles's, the return was 4 per cent. on the outlay, and had been 4½ per cent.

The Metropolitan Association for Improving the Dwellings of the Industrious Classes, which is the other Society referred to, had, up to 1860, expended on its ten distinct ranges of dwellings 89,613*l.* 14*s.* 10*d.*, of which 71,328*l.* 2*s.* 6*d.* was laid out on six separate blocks of dwellings in different parts of the metropolis, accommodating 395 families; the net return from these buildings for the year ending 31st March, 1860, after deducting all current expenses and repairs, amounted to 2,687*l.* 4*s.* 4*d.*, being about 3½ per cent. on the outlay.

On two lodging-houses for single men—one of them new, which has accommodation for 234, and the other old, which provides for 128—the return, owing to the want of sufficient occupants, has been very unsatisfactory; involving, indeed, a considerable loss, which proves that the buildings are either too large, or in some way unsuited to the class of men frequenting their neighbourhood.

It is worthy of observation that the same result has attended a similar lodging-house which I have seen at Marseilles, built outside the town, for 150 men, too far from their daily occupation; whilst many such houses elsewhere, on a smaller scale, accommodating from 50 to 100 men, and near to their work, have fully succeeded; in some instances they have been gradually increased, which is the case at Leeds and at Liverpool. Of two adjoining houses, built on the Boulevard de Batignolles, in Paris, to accommodate together 203 men, and having on the ground floor a restaurant and café, one was closed three years since. In this instance, however, the failure is doubtless in some degree attributable to defective management.

From the experience of these two Societies in the metropolis, it would appear that old buildings may be renovated and fitted up for men's lodging-houses, with the prospect of, at least, a fairly remunerative return on the outlay; in the instance of the Charles-street lodging-house, it has averaged from 12 to 15 per cent., though, in some other instances, the return has been under 5 per cent. Whilst the putting of old courts and blocks of dwelling-houses for families into a good sanitary condition, unless they are obtained at an unusually low price, is not likely to yield a satisfactory return on the outlay, at all events, if done by societies, and taking 4 to 5 per cent. as the lowest rate of interest which such

* This return, though a considerable increase on that of the previous year, is not encouraging, the property being old and leasehold, and no provision for a sinking fund having been made.

investments ought to yield, after provision has been made for repairs,* and a sinking fund to pay off the capital; which it is obvious there should be, especially in the case of leasehold property.

Highly valuable as must be the results of the transformation effected in two of the courts referred to, where filthy dens became decent and healthy dwellings, the actual benefit arising out of these efforts was not conferred to the extent which might be supposed on those who were the occupants of the courts when they were taken by the Society; a considerable portion of them having been ejected in order not only to reduce the number of occupants within a due limit, but also to secure a more eligible set of tenants. My own conviction is very decided that the owners of such property† should be compelled by the law, either to put it into a healthy condition, to close it altogether, or to part with it at its fairly ascertained value to those who may be willing to undertake the necessary outlay. At present, the fact of such property being inquired for by philanthropic persons gives to it a fictitious value; and in numerous instances within my own experience, the object has thus been defeated, or the price paid for the property has been so high that, with the outlay on repairs, its net return is such as to discourage any further attempts of the same kind. An Act of Parliament passed in 1855, and applicable only to Scotland, contains a clause which, in a certain degree, meets such cases; but it appears to me that the principle involved in the entire prohibition of the sale of articles of food, when in an unwholesome condition, applies, with undoubted equity, to dwellings, and that its legal enforcement is the only way of effectually remedying the evil.

Whilst the experience of the two leading metropolitan societies in regard to *old buildings* shows such results—and, as far as my information goes, it accords with that of some other societies—I am glad to notice instances of individual effort which have been completely successful, owing, there can be no doubt, mainly to the exercise of a sound judgment and more careful management in the cases referred to.

In the parish of Chelsea, your honorary member, the Rev. Richard

* The average expenditure on repairs to new buildings should not exceed 1 per cent., and may often be less, whilst it would not be safe to calculate those required to old buildings at less than 1½ to 2 per cent. on the average.

† In a Report lately made by Mr. Nugent Robinson on the Dwellings of the Poor in Dublin, it is stated that "the wretchedness of their dwellings is mainly owing to a class of people called 'house jobbers,' who buy up dilapidated houses, and re-let them, either by the house or by the room. As a general rule the jobber remains behind the scenes, while the actor is some low Irish agent employed on commission to collect the rents by hook or by crook. The 'jobbers' are utterly averse to ameliorating the condition of their tenants, when anything like expense has to be incurred. It is to be regretted that many men of social position belong to this class." The existence of the same evil in our own metropolis has been pointed out long since.

Burgess, and some friends, established, in 1851, two of the earliest renovated houses for families, which have proved an admirable example for those disposed to promote this object in a quiet and unpretending way. The houses are always filled with good tenants, on whom the most favourable results have been produced, and from the net receipts, after the payment of 5 per cent. interest on the outlay, which was 300*l.*, that amount was entirely paid off at the end of 8 years, and since then, there has been a clear profit of between 30*l.* and 40*l.* per annum.

To give another example in London: a few months since I went over a considerable property in the city, part of which, in a central locality, comprises dwellings for 86 families of the working class, and, in another, three entire courts. The owner is a private gentleman, who derives his chief income from house property. On coming into its possession he felt the responsibility of ownership, and desired to put it into a condition fit for the occupation of well-conducted tenants. I can testify to his entire success in that respect, and also to the contrast with the neighbouring property which his presents. All that he was anxious to do has been accomplished without pecuniary loss. His rent-book, kept with much exactitude, shows the greatest regularity of payment, and this he told me compensates for extra expenditures on various objects beneficial to the tenants. The following results of the experience gained in this instance may be useful. Of the gross amount received weekly and monthly for rent, about one-fourth covers the taxes and general repairs, or one-third covers the whole of the landlord's expenditure, including the collection, expenses of schools and medical attendance. A great secret of success has been the forbidding the practice of underletting as a rule, though occasionally a lodger is allowed. Another custom which has the same tendency, is that of the owner going over the property himself frequently. With much consideration and justice to the proprietor, one part of this property was, on a recent application made to Parliament by a railway company for power to take it, treated as an exceptional case, and allowed to remain as an instructive lesson to neighbouring owners: amongst others, the railway company which coveted its possession.

The success which has—doubtless, in the main, owing to careful management—attended the Society at Hastings, renders it worthy of special notice. It was established about five years since, and has now a paid-up capital of 16,000*l.*, of which 14,000*l.* has been expended in purchasing the freehold and putting into good condition about 130 old cottages and two lodging-houses. An annual dividend of 6 per cent. has been paid to the subscribers, besides laying by 1 per cent. per annum as a reserve fund. A benevolent fund is formed among the tenants, and two visitors inspect the property every fortnight.

The three examples referred to in succession, after the two metropolitan societies, are instances in which *old buildings* have

been exclusively operated upon. I shall now briefly allude to some instances in which societies have constructed new buildings, with more or less pecuniary success; and as there have been, since 1850, from 25 to 30 such societies established in various provincial towns in England, besides those in London, you will not expect me even to name them all.

The Strand Building Company, on their houses for 25 families, in Eagle-court, has paid a dividend of $4\frac{1}{2}$ per cent.

The Windsor Royal Society, which was established in 1852, under the special patronage of her Majesty and the lamented Prince Consort, has now 9,000*l.* invested in new cottages* and in two lodging-houses; the net returns from which, owing to temporary circumstances, have latterly yielded 4 per cent. to the shareholders, instead of $4\frac{1}{2}$ or 5 per cent., which they would otherwise do.

The Rodhill and Reigate Cottage Improvement Society, in a late report, stated that, from the eagerness with which their first built cottages were taken, they have been induced to add twelve to the nineteen with which their operation commenced, and since then eight more have been built. The contract for the second series was at the rate of 120*l.* 7*s.* 1*d.* per cottage. A dividend of 5 per cent. has been paid to the shareholders, and 65*l.* 16*s.* 3*d.* added to the reserve fund, with every prospect, apparently, of the same dividend being continued. These cottages are very near to the railway station, and have a neat appearance; they resemble much some of those built by the Windsor Royal Society.

Amongst the efforts which may be classed with those of associations, are the model lodging-houses built by the Huddersfield Improvement Commissioners, in pursuance of powers granted by their Acts of Parliament; and this, I have been informed, is the only instance in which municipal authorities have erected such buildings at the public cost, and out of improvement rates. Provision, in this instance, is made for the accommodation of 221 men, 34 single females, and 12 married couples.

The Corporation of the city of London contemplated, in 1855, the construction of several large piles of buildings for the occupation of such of the working classes as were ejected from their dwellings in the formation of new streets; but actually, nothing has been accomplished.

It is not necessary for me to notice at length what has been done in Scotland, where, however, exertion, both in the towns and the country, is quite as much needed as it is in the south. The lack of municipal supervision in Edinburgh was proved very recently by a melancholy catastrophe, which issued in the death of 35 human beings, and brought prominently into view the way

* The plans given by me for twenty of these cottages, which are in pairs and in blocks of four tenements each, have been published by the Labourers' Friend Society, and will be found in the third edition of my Essay on the "Dwellings of the Labouring Classes."

in which the poorer population are huddled together in gigantic buildings of seven and eight stories, divided into dwellings of one and two rooms each. The painful scenes I have witnessed in Edinburgh, arising obviously, in a great measure, from drunken habits, rival those met with in any part of the Continent.

In a paper* which I read at the Glasgow meeting of the National Association for the Promotion of Social Science, and which is published in the Transactions of the Association for 1859,† a somewhat detailed account is given of numerous blocks of improved or model dwellings which have been constructed in Edinburgh since 1850. In several of these, but very recently finished, the external gallery (supported by cantilevers) and open staircase system has been adopted; and in other instances, where there is only one upper story, the dwellings in that part—for all are arranged in flats—have their approach on the opposite side of the building to that on which the ground floor is entered, and the access to each dwelling is through its own garden. The Pilrig model buildings, near Leith-walk, is an example of this arrangement; there are 44 houses, the cost of which, including drains, was 92*l.* per house, and they pay to the shareholders a dividend of 5 per cent., exclusive of additions to a sinking fund.

An association in Glasgow, comprising about 12 spirited gentlemen, is engaged in purchasing the property which will enable them to cut a new street through one of the most miserable "closes," and to improve right and left the wretched property. Through the exercise of much discretion, the greater part has been obtained for 8 years' purchase on the rental. 15,000*l.* is advanced for the purpose by bankers, at a moderate rate of interest, on the personal guarantee of the members of the association against loss.

The efforts made in Ireland for improving the dwellings of the working classes may be learned from an address by Lord Talbot de Malahide, and from other papers given in the Transactions at the meeting of the National Association for Social Science in Dublin, 1861.

It has been often remarked, in reference to several such undertakings as have been referred to, "that the most necessitous of the working classes are not benefited thereby." In reply, I would say, that it is the want of an adequate supply of such houses which, in most of our thickly-populated towns, forces so many working people into miserable, crowded, and unwholesome dwellings, where they gradually sink in the scale of physical and moral position, ending their days prematurely.

The measures for improving the dwellings of the labouring classes, which have, from benevolent motives, been taken by asso-

* A copy of this paper is in the library of the Institute, as well as another, on "The Improvement of the Dwellings of the Labouring Classes," read by the author, at the meeting of the same Association, held in Liverpool in 1858.

† Other papers which describe the dwellings of the poor in Glasgow are given in this vol.

ciations on the Continent, and in the North American States, are so distinctly traceable to our own in England, that it would not be right to pass them entirely over in silence.

I have noticed already those adopted at Mulhouse, in France,* and have alluded incidentally to some others. All that was done in Paris, to the summer of 1858, I have seen; and having conversed on the subject with those most competent to form a correct opinion, feel warranted in saying that the good intentions of the Emperor, in appropriating 10,000,000*fr.* to the encouragement of this object, in the form of a subvention of one-third the outlay, have not, excepting in a few instances, been seconded. Most of those who engaged to any extent in the enterprise appear to have done so exclusively as a commercial speculation, expecting to derive a considerable pecuniary profit, and uninfluenced by benevolent motives. In addition to this unfavourable feature, the leading French society had a similar misfortune to that which befell one of the earliest established societies in London, through the misconduct of the then secretary, causing in both instances a very serious discouragement to the work. It is necessary to refer to these adverse occurrences, as they alone will account, in a great measure, for the sudden check which this movement had in both capitals between five and six years since.

Turning to a brighter feature of the case, I mention with pleasure, that when passing through Paris last autumn, it was stated to me, on reliable authority, that a very considerable number of suitably arranged dwellings have been recently built in different directions by private enterprise, and with a return of full 8 per cent. on the outlay. Thus, as in our own experience, private enterprise has proved more successful, in a pecuniary point of view, than similar work undertaken by societies.

The first society on the Continent to follow the example given in England, is stated by Dr. Huber, who was for some years its secretary, to have been that in Berlin, formed under the patronage of his Majesty the King, to whose enlightened and personal interest in the work I can testify, having on two occasions had the honour of conversing with his Majesty on this subject. At a late meeting of the society, over which his Royal Highness the Prince Frederick William presided, it appeared that the capital embarked is about 34,655*l.*, and that there are dwellings for about 219 families and 31 work-shops; the number of occupants being 1,168. The shareholders receive a dividend of 4 per cent., and the available addition to the reserve fund was in one year about 3,195*l.*, one-half of which was, however, repaid to the tenants. At the same time, the annual meeting was held of a kindred, but smaller, society, called the "Alexandra Stiftung," by

* Those who desire to know something of the actual condition of the working classes in France, will do well to consult a recent work, "*L'ouvrière*," par Jules Simon.

desire of the Emperor Nicholas of Russia, who, at its formation in 1852, gave 1000 ducats to the funds. They amounted, in 1858, to about 21,338*l.*, partly arising out of donations and partly from loans at 4 per cent.

With an express view to the construction of suitable dwellings for the working classes in St. Petersburg, where they are greatly needed, an architect was deputed to visit London about three years since, and a large number of such houses have been built by a company formed for that purpose.

At Frankfort, a society formed on a strictly commercial principle, to supply a want greatly felt in that city, is now in successful operation, under the guidance of its energetic and philanthropic promoter Dr. Vancrapp, who visited England eighteen months ago to obtain information on the subject.

More recently, a gentleman from Bremen has been to me for advice in regard to the carrying out of an extensive undertaking, which contemplates the building a very large number of workmen's houses on church property, without the city. The remarkably favourable terms required for the ground, and the unusually low rate of interest sought for by the projectors, prove the earnestness of all engaged in this good cause, and how really anxious they are to meet the necessities of a case, which is here seen to be, as it is in reality everywhere else, most intimately connected with the well-being of the masses of the population. The study of this example might be profitable to some in our own country.

The usual rate of interest which is sought from such undertakings on the Continent appears to be 4 per cent., with a small sinking fund for paying off the capital. In some few instances it is 5 per cent., and the opportunity is frequently afforded the tenants of becoming the owners of their own dwellings, by a gradual payment, in addition to the rent—a system which renders the dwelling a saving bank, and has been found greatly to stimulate habits of forethought and sobriety.

Much time would be occupied were I to enter on any detailed account of what has been done for this object in other countries besides those named already. The movement has extended to Norway, Denmark, and Sweden, to various towns in Holland, and to Belgium,* where enlightened views on the subject have been advocated in two International Congresses, held under the patronage of the King and the royal Princes. In Bavaria, and in several of the minor German states; in many parts of Switzerland and Italy, model houses now exist. One of the earliest and best arranged is in Florence; it accommodates 100 families; and another range is in progress. How greatly sanitary improvements have long been needed in most parts of Italy, many of my auditors can

* The Belgian Government has published an instructive series of resolutions on the construction of dwellings, which was drawn up and adopted at the meeting of the Congrès Général d'Hygiène, held in Brussels in 1852.

testify, whose first recollections of Rome and Naples are of a more recent date than mine, which go back to 1828-29. When I was at Genoa in 1856, its chief magistrate told me that the municipality had there been put to an expense of 500,000*l.* sterling during the recent attack of cholera, mainly in relieving those of the population who live in narrow streets and filthy dwellings; and he added, "I can now, from experience, confirm what is stated in the publications you formerly gave me, as to the heavy expense which may be incurred in consequence of a defective sanitary state." It is rejoicing to know that Naples is in this respect greatly benefited by its emancipation from a rule so jealous of the semblance of foreign interference, that our ambassador cautioned me against the attempt to diffuse any of that light which even Cardinal Antonelli had spoken of as being especially needed at Naples.

A periodical which has a wide circulation in the North American States, published much of the paper I read before the Institute in 1850, together with plans of the Streatham-street model houses for families; and since then, partly, no doubt, owing to the great interest taken in this object by the late Mr. Abbott Lawrence, American Minister in London during the Great Exhibition, piles of well-arranged model dwellings for families, five stories high, have been constructed in New York and in Boston. In the former city the return on the capital invested is 4 per cent., and in the latter, 6 per cent., with reference to which it is stated that "the effect of proving that houses for the poor can be built on the best plan for the health and comfort of their inmates, and, at the same time, be good investments of property, is manifest in many private undertakings. Several large houses have been already built on similar plans; old lodging-houses have been in many instances remodelled and otherwise improved."

The measures adopted by *individuals*, with a view to aid those in helping themselves who need such aid, remain to be noticed.

Our most gracious Sovereign has honoured by her royal patronage two societies established for this object, and has given substantial proofs of interest in their success; whilst the labourers' dwellings belonging to Her Majesty abundantly manifest a kind and thoughtful regard for the welfare of their occupants. These are but some amongst many other illustrative facts which might be adduced to show that the feelings of the lamented Prince Consort on this subject "are," in the words already quoted, "entirely and warmly shared by her Majesty the Queen."

Much has been done towards a fulfilment of the desire so happily expressed by an ancestor of our gracious Sovereign, "That a Bible should be placed in the dwellings of all his subjects," and we rejoice at it; but who that knows the actual state of vast numbers of those dwellings can be unaware of the obstacles they present to the profitable reading of that book, and to the embodiment of its holy precepts in the daily life of their occupants?

I have briefly stated some of the efforts made of late for the removal of those formidable obstacles which impede alike the physical, the moral, and the religious improvement of the masses of the people, and have endeavoured to point out the practical means which are calculated, through their extensive adoption, to diffuse more widely the benefits of a healthy dwelling amongst our labouring population.

It is my conviction that the feeling of a weighty responsibility, which rests, much more extensively on the upper and middle classes in regard to this matter than is generally admitted, needs to be pressed home and brought into more active operation than it has hitherto been.

With this view I desire to urge on all the example of that truly great and excellent Prince, whose irreparable loss must be long and deeply felt in every branch of effort connected with the objects of social science. And it is with the earnest hope of encouraging and stimulating many to follow in a path which has been trodden by one so illustrious, that I bring before you some of the many and wide-spread results traceable to a single manifestation of the great interest felt by his late Royal Highness in the subject under consideration.

The Commissioners for the Exhibition of 1851 having replied to an urgent application made for a site, "that a model lodging-house does not come within the design of the Exhibition," a memorial on the subject was presented to his late Royal Highness, who immediately expressed the most lively interest in the project, and a desire that the contemplated model houses should be constructed on his own account, in effecting which, it was my privilege to act for his Royal Highness as honorary architect. With much personal trouble to the Prince, the requisite official consents of four Government departments were obtained, for placing the houses in the Cavalry Barrack yard, opposite to the Exhibition. An objection to this site was made by the Commander-in-Chief the Duke of Wellington, lest they should give rise to a feeling of dissatisfaction in the army with the want of any accommodation for married soldiers; an evil which his Grace apprehended the country to be then unprepared to remedy. I notice this fact in order to show how clearly their effects were foreseen by the great Duke, and how speedily good results arose out of their construction. Within twelve months after the Exhibition, a large and well-arranged lodging-house for married soldiers was commenced near the Vauxhall-bridge-road, by an association of officers of the Battalion of Guards.

The benefits resulting from this first essay soon led the Minister of War to commence building separate dwellings for the married non-commissioned officers and men at Chatham Garrison; and a grant of 30,000*l.* has been made by Parliament for carrying out the same object elsewhere, at the instigation of that great friend of the soldier, and, I may add, of the labourer also, the lamented Lord Herbert. In a note, dated as recently as April last, that dis-

tinguished example of sacrifice to self-denying duty expressed to me his "hope of seeing a great change in the next few years in the dwellings of the rural population." I mention this as an additional call to zealous effort in the good work, for "the night cometh wherein no man can work."

Amongst the number of visitors to the Prince's model houses, amounting to upwards of 250,000, many gave evidence of their having duly appreciated the object for which they were placed in the Exhibition, viz., the conveying practical information, calculated to promote the much needed improvement of the dwellings of the working classes, and also of stimulating those whose position and circumstances enable them to carry out similar undertakings, and thus, without pecuniary* sacrifice, permanently to benefit those who are greatly dependent on others for their home and family comforts. The building was adapted for the occupation of four families of the class of manufacturing and mechanical operatives who usually reside in towns, or in their immediate vicinity—those, in fact, by whose labour the larger portion of the objects in the Exhibition had been produced.

The open staircase and gallery, giving access to the upper-floor tenements, were prominent features in the arrangement of these dwellings, and their subsequent adoption in buildings constructed for working people in towns, has come under my notice in Edinburgh, at Liverpool, Ramsgate, Brighton, Windsor, and other places, as well as in London and on the Continent.

The example which may, perhaps, be pointed to in London as bearing the closest resemblance to the original structure, and as fully answering in a pecuniary point of view, is at Cowley-street, Shadwell, close to a station on the Blackwall Railway, where a number of miserable dwellings, tenanted by the lowest class of persons, came by inheritance into the possession of a private gentleman, W. E. Hilliard, Esq., of Gray's Inn. Actuated by the most philanthropic views, he decided on endeavouring to improve, not only his own property, but also by example the immediate neighbourhood; and his efforts have been crowned with signal success. The old dwellings have been replaced by an entire street of considerable length; on both sides of which houses for accommodating in the whole 112 families have been built, on the general plan of the Prince Consort's Exhibition model houses, with open staircases, giving access to the upper-floor tenements. The twenty-eight blocks of four houses cost 457*l.* each; and, after allowing for ground-rent and all charges, I can state on the authority of the owner, that "they continue to pay upwards of 6, in fact nearly 7 per cent. as a net return on the investment; and what," he adds, "is perhaps of more consequence, they are almost constantly let, and are appreciated

* This point was justly held by H.R.H. to be of primary importance to the adequate extension of the work. The detailed estimated cost of the model block of four houses was 458*l.* 5*s.* 6*d.*

by the tenants, who, as a rule, are pretty stationary, and not migratory, as that class frequently are." The Report of a Public Officer on these houses, has been already quoted.

Scarcely any foreigners who visited the Exhibition of 1851 returned without carrying back to their several countries some of the publications bearing on the improvement of the dwellings of the labouring classes, which were there abundantly distributed. My own opportunities of judging of the effect of this little structure enable me to say that it gave to the movement an impulse such as it has not received from any other single effort, the results of which have spread far and wide. The descriptive account of the building was translated into German and published at Berlin, much of it also appeared in French.

The collection of sanitary and other appliances adapted to the circumstances of the working classes, which occupied a part of the cottages was the first public exhibition of the kind, and which I had hoped to see continued and increased, when, at the close of the Exhibition, the building was removed to Kensington-park, under the charge of the Office of the Woods and Forests; a proposal with that view having been made to the Chief Commissioner, Lord Seymour. The practical value of such a collection was recognised at the Congress General d'Hygiène, held in Brussels in 1852, where, on my proposal, "the utility of establishing in each country, and also in the principal centres of the population, a collection as complete as possible; a kind of museum where shall be gathered together models, plans, specimens of materials, &c., relating to hygienic amelioration and progress," was unanimously declared.

The Economical Museum, formed by my worthy friend Mr. Twining, at Twickenham, is an expansion of the same idea.

Amongst the numerous other instances of individual effort which might be given, I shall only notice—

1st. The building in Lambeth, on the property of his Royal Highness the Prince of Wales, as Duke of Lancaster—a considerable range of model dwellings for families, with shops on the ground floor, at a cost of 16,000*l.* The close proximity of extensive gas works has, I regret to say, impeded that full occupation which is almost invariable in such buildings elsewhere.

2nd. The establishment, by Lord Kinnaird, in Peter-street, Westminster, of some of the earliest renovated model lodging-houses, and his promotion of similar houses in Dundee. In the latter case, the original outlay, as well as the interest thereon, has mostly been paid out of the profits. Although the beneficial operation of the Lodging-house Act has tended to diminish, in some measure, the great necessity for such houses, the adoption of a suggestion made to me by Lord Kinnaird, would doubtless prove of great service to those of the working classes who migrate in search of employment. It is "that every town ought to have a model lodging-house, with notice thereof stuck up at the different railway stations."

3rd. Miss Bardett Countess has contributed in various ways to the object under consideration, the most important of which is the building, under the direction of Mr. H. A. Darbisher, a considerable range of dwellings for working people in Bethnal-green, one of the poorest parts of the metropolis. In the upper part of this structure, which is four stories high, a covered area for exercise, and a play place for children, as well as a laundry, are provided.

4th. The five piles of family dwellings,* built by Mr. John Newson, in different parts of the metropolis, although susceptible of improvement in some of their details, deserve to be mentioned, on account of the striking contrast which they present to the dwellings generally occupied by the working classes in London. They accommodate 125 families, and have cost 13,200*l*. The annual gross receipts are 1560*l*, the ground-rent, taxes, current expenses, and repairs average 830*l*, which leaves a net return of about 5*1*/₂ per cent. on the outlay. All these buildings are arranged with open galleries, resembling, in that respect, the Streatham-street and the Prince's Exhibition model houses, which renders them exempt from house duty, each tenement so approached having been pronounced by the Judges to be a separate house in regard to taxation. One important recommendation of this system, besides that of its healthful tendency, from the free circulation of air, and the distinctness of the tenements.

The construction of such houses as these ought, even from self-interested motives, to be encouraged by *Parochial authorities*, which might frequently be done in their rating, in consideration of the diminution in the charges ordinarily arising out of the sickness of the poor.

The scope of my paper will only admit a passing remark with reference to Benefit Building Societies,† of which Mr. Tidd Pratt stated recently that there were 2000 with a paid-up capital of 8,000,000*l*. A machinery so extensive, and having such resources, might, if well directed, accomplish much for the object under consideration; but it is to be feared that many of the houses built in connexion with these societies are inconsistent with a healthy and convenient dwelling.

This evil, which has been pointed out to me by the late eminent Dr. Southwood Smith, and other sanitary reformers, would probably be most effectually remedied by the circulation of sound views on the subject, through the medium of Mechanics' Institutions and kindred associations. Here is a fruitful field for individual effort, in the cultivation of which much assist-

* Two of them are in Grosvenor-mews, near Berkeley-square, one in Bull Head-court, King-street, Snowhill, and another is the Bull-inn-chambers, Holborn-hill.

† Those who may desire information as to the working of some of these societies, will find an account of the origin and progress of four such associations in Yorkshire, given in a paper read by Mr. J. A. Fenn at the Bradford meeting for Social Science, and published in the Transactions of the National Association for 1859.

ance might be derived from the exhibition of suitable plans for the dwellings of working people, as well as from small collections of domestic appliances conducive to health and comfort.

The nucleus of such a collection was formed under my direction at the office of the Labourer's Friend Society more than twelve years since, and the idea was carried out, as already noticed, on a very small scale in the Prince's Exhibition Model Houses, 1851, as well as in the compartment belonging to the Labourers' Friend Society in the Exhibition itself.

Experience having shown me the great necessity for a general diffusion of sanitary knowledge, I was led to follow up the declarative resolution in regard to the establishment of illustrative museums, already referred to, as having been adopted at the Congress d'Hygiène in 1852, by proposing at the Congrès International de Bienfaisance, held in Brussels in 1856, the following resolution: "The Congress declares that it is of public utility that the working classes be enlightened by all possible means in regard to the improvement and keeping of their houses in good order. It declares that the instruction of the young in the labouring classes ought to comprise all which relates to the benefits resulting from good ventilation, and the evils resulting from humidity. Lastly, it thinks that the study of the science of preserving health is one which ought to be rendered accessible to all." The unanimous adoption of this resolution by the representatives of upwards of twenty different countries, recognised the wide-spread extent of the ignorance referred to, as well as the serious nature of the evils resulting therefrom.

Amongst individual efforts for promoting the object under consideration, the prominence given to it as an object of vital importance, in public addresses by many distinguished statesmen, ought not to be forgotten; those of Lord Palmerston have justly carried with them all the weight and high official influence of Prime Minister.

Within the last five years many Ladies have directed their zealous efforts to objects which tend in various ways to domestic improvement. The Ladies' Sanitary Association, the Female Domestic Mission, connected with Bible colportage, and Meetings for the Instruction of Mothers, exercise a highly beneficial influence in this respect.

Notwithstanding, however, all our recent ameliorations* it is

* The beneficial results of sanitary improvements effected within ten or twelve years in several of our large towns are manifest from the following returns, out of nineteen which have been obtained. In the metropolis the death rate has been reduced from 25 in 1000 to about 23; in the Liverpool district, from 32 in 1000 to 26; in the Bradford district, from 28*1*/₂ in 1000 to 20; and in the Croydon district, from 28 in 1000 to 21. Knowing, however, as we do, that the normal standard is certainly not above 17 in 1000, these results are a proof of our responsibility, as well as an encouragement to perseverance in the discharge of duty.

a well-ascertained fact that tens of thousands of human lives are sacrificed annually in Great Britain through ignorance and the culpable neglect of means within our own power. But, owing to the noiseless and almost imperceptible way in which such multitudes are carried off by preventable diseases, and their homes desolated, we witness no manifestation of the practical sympathy so justly shown by the public, when, through some lamentable accident, a score, or perhaps hundreds, are suddenly deprived of life, and their families of the means of subsistence.

When recommending sanitary ameliorations to influential persons on the Continent, the misery and degradation in which vast masses of our fellow subjects are sunk, owing, in a great measure, to their domiciliary state, has been so often pointed at as a reproach to England, that the words "Physician, heal thyself" have frequently occurred to my mind, as a call to renewed exertion for this object.

And now, in conclusion, if the remarks offered and the facts stated have tended to show that it is not through the exclusive adoption of any one of the means which have been pointed out, nor by any infallible specific, that the benefits of a healthy dwelling can be extended to all classes of the working population, I yet entertain a sanguine hope that through the general and earnest adoption of a combination of suitable measures, existing evils will be greatly mitigated, if not entirely rooted out. Such an expectation is warranted by the well-known results of the improvements in our prisons, which are no longer hotbeds of fever and of moral contagion as they formerly were. Whilst the ameliorations very recently introduced in our military barracks and hospitals have led to a diminution by one-half in the mortality of their inmates, as was lately stated by the Chancellor of the Exchequer.

Encouraging facts like those should stimulate all to exertion in their various spheres of action, in order that the labouring population may, to apply the words of his Royal Highness the lamented Prince Consort, adopted for my motto, participate "in the blessings bestowed on us by the Almighty," but which, in their case, "can only be realized in proportion to the help which we are prepared to render to them."

In illustration of some of the preceding suggestions, two pages of wood engravings are added. The *first* may be useful, in regard to the dwellings generally of the labouring population who are not confined in towns. The *second* is more particularly designed to show an adaptation of the open Gallery System to town buildings, in a way which is but of recent introduction. The arrangement of the lower plan will admit the occupancy in sets of two, three, or four rooms.

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Elevation which admits of more ornamental details.



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Plan on Ground Floor.

Plan on Upper Floor.

20 5 0 20 20 30 40

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A TREATISE
ON
SMOKY CHIMNEYS,

Their Cure and Prevention.

BY
FREDERICK EDWARDS, JUN.

LONDON:
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PREFACE.

THE following little treatise has been prepared with the hope that by its aid any man of education may be able to become somewhat fully acquainted with the subject of smoky chimneys; to trace out the cause of any such nuisance with which he may be inconvenienced, and to apply to it its most appropriate remedy. It is also hoped that any practitioners who may have relied on some single scheme, as a cure for all disorders, will be able, on fully considering the various reasons why many chimneys smoke, to attain a more philosophical understanding of the subject, and, thereby, to give to their practice a more extended success. The recommendations, by the adoption of which smoky chimneys may, it is believed, be avoided altogether in new buildings, will, it is hoped, be made extensively known by the periodical press. An author's efforts without such aid can confer but the smallest possible amount of benefit on the public, and bring little or no satisfaction to himself.

49, Great Marlborough Street,
Nov. 9th, 1864.

A TREATISE ON SMOKY CHIMNEYS.

ABOUT seventy years ago smoky chimneys in England were so common an evil, that not only were there no houses without them, but the chimney that would "draw" well in all states of the atmosphere, without the temporary assistance of an open window, was exceedingly rare. Count Rumford appeared, and, in essays which have gained esteem for the author of them, wherever they have been perused, established rules for the construction of our fire-places, which have gained for us the very large amount of fire-side comfort we now possess. In the course of fifty years, a smoky or doubtful chimney has become the exception instead of the rule, and we can now wonder, that so long a period as a hundred and fifty years should have elapsed, from the time when coal became extensively used in domestic fire-places, before such simple and effective contrivances as those recommended by Count Rumford, were even introduced.

It will be well to make a general examination into the various causes why many chimneys entirely, and others on certain occasions, fail to perform their proper functions, and to endeavour to ascertain whether or not, by the application of indubitable and recognized principles, these may be reduced in number to a very small residue, with which, short of their reconstruction, it would be worse than idle for any one to interfere. By indicating also the errors of construc-

tion in the most difficult cases, we shall observe what should be avoided in the future.

It may be well to state, in a few words, how heat operates in our fire-places, to carry off smoke and other products of combustion. It is well known that when air becomes heated by radiation from the earth, or any other medium, it instantly expands and rises, cooler air filling its place to be heated in its turn, to expand and to rise. The upward passage of such air becomes arrested by its having gradually parted with its heat, and lost with it, its comparatively rarefied condition. In a closed building, the passage of heated air is arrested by a roof; so, also, in an apartment, by the ceiling; where, unless there are disturbing causes, the coldest air will naturally be near the floor, and the warmest near the ceiling. As soon as the air in a house or a room attains a temperature exceeding the external, there is a constant tendency for the colder air to enter by every, even the smallest, opening, and to displace the warmer and lighter air, which, as a rule, seeks higher points for escape. If a window be opened above and below, the quantity of air entering by the lower aperture will displace a similar quantity escaping at top, or by the chimney. If a door of a room be opened, where a fire is burning, a current of air rushing in at bottom may be observed with the aid of a lighted paper and a reverse current at top. If air is excluded altogether from entering the room, either by door or window, it inevitably enters by the chimney, provided only that the external air is colder, and therefore heavier and denser than the air in the room. The simple conditions upon which we depend, that there shall be an upward current in a chimney, are—1st. That the air in the room is warmer than the external air. 2nd. That the external air has freer means of entrance to the room than by the chimney, viz. by the openings round a door or window, that the displaced air may find its point of escape at the chimney. It will be obvious

from this, that if houses are constructed so as to allow a free entrance to external air at many points, the chimneys will perform the office of channels of exit for rarefied air. If this is not attended to, or is intentionally frustrated, air enters by the chimneys. When a fire is made in an open fire-place, air becomes heated by contact with the burning fuel, and immediately rises, carrying with it smoke, carbonic acid, &c. If there is an upward current of air in the chimney, the products securely pass away. If, on the contrary, there is a down current, they are instantly emitted into the room. If there is no current at all, and the air is therefore stationary, the rise of heated air from a fire warms the air in the chimney, and an upward current is established, which is accelerated according to the degree of intensity with which the fire burns. The more the air in the room becomes warmed and rarefied, the more the external air rushes in by the doors and windows, and supplies that pressure of air from the room by virtue of which the ascensional current is maintained. If the general body of air in the room is allowed to become more rarefied than the general body of air in the chimney, air flows from the chimney to the room, bringing smoke with it. If, on the contrary, the air in the room is maintained in a less rarefied state than the air in the chimney, the ascending current continues. Having thus explained the simplest view which can be taken of the action of chimneys, we will enquire what are the disturbing causes which hinder them from performing their proper functions; in other words, why they sometimes smoke.

Cause 1.—From a fire-place being too open.

Cause 2.—From the doors and windows of a room being fitted too closely.

Cause 3.—From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

Cause 4.—From a chimney being very short.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Cause 6.—From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.

Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

Cause 9.—From the top of a chimney being situated below a pitched roof.

Cause 10.—From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.

Cause 11.—From a short chimney being enclosed on three or four sides by high contiguous buildings.

Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.

Cause 13.—From chimneys of one house being lower than those of one adjoining.

Cause 14.—From a chimney being too small for the fire-grate used.

Cause 15.—From two fire-places being used for one chimney.

This appears to be a rather imposing list. It will be found, however, that some of the causes are so similar in nature as to be nearly identical, and that the remedies are, without exception, referable to very few and simple principles. Two other causes may be mentioned, which require no discussion; viz. that sometimes a chimney is found to be unsound, and, in consequence of a crack, admits a body of cold air; and, that a chimney which has given considerable annoyance, and puzzled many practitioners, has been found to have no other fault than that of having been accidentally stopped in some part by a mass of fallen brickwork.

Cause 1.—From a fire-place being too open.

Questions relative to the proper construction of fire-grates have been entered into at length in another treatise,* but some leading recommendations necessary for the proper elucidation of the subject now under discussion will be here reproduced. A fire-place more open than is necessary, for the most effectual use of an open fire, is the old evil so much combated by Count Rumford, and, even now, probably, the most frequent cause of a smoky chimney. Fig. 1 represents an old-fashioned grate with hobs, in which the Count's recommendations have been almost entirely disregarded. When a fire is lighted in such a grate, if there does not happen to be a good upward current in the chimney, an immediate effect produced by the rising of warm air is a rush of cooler air from the spaces over the hobs, which drives smoke into the room. If, however, the hobs are discarded, and if air from the room can, therefore, only press to the chimney directly over or between the fire bars, no hindrance from such a cause can prevent the proper escape of smoke. A farther inducement to discard such grates is that their form is very inappropriate for the effectual radiation of heat. The metal sides and back, *a, a, a*, receive a considerable amount of heat by conduction, which heat, however, they communicate to the currents of air which pass up the chimney and to the brickwork behind, so that the metal remains comparatively cool and radiates little heat. If, however, the back and sides of a grate are formed of fire-brick, which, being a non-conductor of heat, retains what it receives and therefore radiates it powerfully; if they are continued straight up from the fire, as shown in Fig. 2, and if the sides are placed at such an angle as to radiate in a proper direction the heat they receive,

* 'On the Economical Use of Fuel and the Prevention of Smoke in Domestic Fire-places, with Observations on the Patent Laws.' By the Author.

a fire will burn much brighter, and with far greater economy of consumption, than in a grate of the former description.

But, it is not merely necessary, on the score of efficiency and economy, to have a contracted form of grate. It is also necessary to provide means for contracting the opening into the chimney, and such means as can be used once a day, if necessary, without inconvenience. If no such means are provided, a considerable quantity of air, warmed by contact with the burning fuel and some heated parts of the grate, escapes at every moment freely up the chimney. The effect of such free escape of air is, that colder air rushes in by the doors and windows with much energy, and passes at once to the most rarefied part of the room, viz., to that in the neighbourhood of the fire-place, thereby creating disagreeable draughts. Many may suppose that a very free escape for air by the chimney is promotive of ventilation, and it certainly is so to a limited extent; but, it must be remembered that, when a fire is burning it is the coldest air, that which comes fresh from outside, which rushes with greatest force to the fire-place, and not the warm air of the room. A truly effective system of ventilation can only be obtained by other means.

It may also be said that a free escape of warm air up by chimney improves the current and effectually carries of the smoke. This is true, and it is well to make the current secure; but, if the upward current is much more than secure, we make a great portion of the coal burnt to answer a most unnecessary object, and we are inevitably inconvenienced by draughts of cold air. Fig. 2, and the section fig. 3, represent a grate with an improved register door or regulating valve, *c*, which can be opened and partially or wholly closed by a handle, *a*, in front of the grate. When a fire is lighted the regulator is generally fully opened. As soon as the coal is well ignited the regulator is closed about two-thirds. The handle, *a*,

should be of a non-conducting material, such as ebony, bone, or ivory, which could be used by any person without inconvenience.

Cause 2.—From the doors and windows of a room being fitted too closely.

Draughts of air are very unpleasant, and sometimes render small rooms almost uninhabitable in winter; but, the evil cannot be remedied by depriving the chimney of that pressure of air from the room which is absolutely necessary to prevent a down current. When we state that a fire burns, we mean that a certain quantity of air is becoming decomposed by the combination of its active element, oxygen, with the carbon and hydrogen of the coal, producing thereby heat and flame. The air for this object is taken almost entirely from the room, if there is no free ingress for air from other sources. Partly by this process, partly by the passage of undecomposed air up the chimney, and, partly by expansion from heat, the air in a room often becomes exceedingly rarefied, and if fresh air is not allowed to enter with some freedom, the air becomes in fact more rarefied than the air in the chimney itself. The inevitable consequence is that the air in the chimney being no longer supported by the pressure of air from the room, the balance becomes turned in the wrong direction, and air flows into the room from the chimney, bringing smoke and offensive vapour with it. The best chimney in the world may be readily made to smoke by the simple process of excluding the entrance of fresh air to a room.

By far the best remedy is to provide a special supply of air to the fire. This is commonly effected by means of a tube communicating with an external wall, and passing between the joists to some opening in the neighbourhood of the fire-place. The opening is sometimes in the hearth-stone, and is covered by an open grating, the bottom plate of the fender being pierced with a number of holes. At other

times, the tube is carried behind the grate and the air is allowed to enter the room by openings at bottom near to the fire, as shewn at *b, b*, fig. 2. The latter arrangement may be considered to be the best, as dust and cinders are less likely to enter the open spaces than in the former. Many persons who have adopted the principle now suggested, have made the error of using tubes much too small. The tube should have an area of about the same as the opening into the chimney when the register or regulator is in its usual position, with a good fire burning. This should give about twenty-eight square inches for a room containing a thousand cubic feet of air, and four square inches more for every additional thousand cubic feet. A little more or less is not very material. If a surplus quantity enters to that required by the fire and chimney, air passes into the room; if a less quantity, a small demand for air is made upon the room. If it be considered impracticable to give a special supply of air to the fire, access must be provided by the usual means. If any one has to bear, however, with the inconvenience of draughts of cold air, it may be observed that the evil would be reduced to a minimum by the use of those grates which allow the smallest quantity of air to ascend the chimney. These are the contracted grates, with the regulating valve in the chimney, to which reference has already been made.

Cause 3.—From fires being lighted in two or three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

This cause is similar to the last, but more complicated. When fires are burning in rooms immediately adjoining, and connected by a door, or folding doors, it is generally found that the ascending current from one fire-place is much stronger than from the other. For a short time, both fires may burn very well; but, when the air in both rooms becomes rarefied, a downward current ensues from the chimney of weaker

draught, bringing smoke and vapour. There are generally two ways of remedying the evil; the first, to reduce the quantity of air that can escape by the chimneys; the second, to supply more air to the rooms. The most judicious course, undoubtedly, is to see that the grates are so arranged, that they can abstract no more air from the room than is really necessary to support combustion, and maintain the effectual working of the chimneys—the means for accomplishing which have been fully explained in the last section, and in a former treatise. Though, in two badly arranged fire-places, the pressure of air from the rooms may be insufficient to prevent a descent of air and smoke in one chimney; directly the fire-places are improved, the amount of air which can pass up the chimneys from the rooms is greatly diminished in quantity; the air in the chimneys attains a higher temperature, and becomes, therefore, far more rarefied than before, and it is, consequently, easily upheld by the much less rarefied air in the rooms. The evil is of various degrees of intensity, and, frequently, the use of the regulating valve is all that is required; but, if the doors or windows are fitted very closely, a modification of the existing grates, or their substitution by others of better construction, will be insufficient to remedy the evil, and facility for the ingress of a greater quantity of air to the rooms must be given.

Cause 4.—From a chimney being very short.

An attic, or other short chimney, often smokes in consequence of the pressure of the atmosphere at the top of the chimney being greater in power than the ascensional force of heated air from the fire, so that a downward current ensues and turns back the smoke. Anything that will give a preponderating power to the upward current will remedy this evil. The heightening of the chimney, by means of a zinc pipe, is usually re-

sorted to, as it is well-known that the ascensional current in a long chimney is generally much better than in a short one. This results from the well-known law that, when there is a difference of temperature between the air in the chimney and that situated externally, the air inside moves with a certain accelerated velocity, according to the length of the chimney. A long chimney does not, of course, absolutely create a current, but, as it is much less exposed to the cooling influence of the atmosphere than a short chimney, an upward current can usually be created in it, with very little difficulty, if it does not already exist; and, that current becomes, quickly, much more powerful than one in a short chimney, if other conditions are equal. Before deciding whether or not so unsightly an object as a lengthened chimney must be accepted as a necessary evil, we may enquire what other mode of improving the working of a short chimney, can be found to be effectual.

A law of very great importance in its relation to a fire-place is, that the greater the difference of temperature between two bodies of air, the greater is the velocity with which the lighter ascends, or is forced up by the other; or, in other words, the greater is its force. Therefore, the colder the air is in a room and the warmer the air is which rises from a fire, the greater is the force with which the warm air rushes, or is impelled into, the atmosphere. The air in rooms, with low chimneys, as attics, labourers' cottages, &c. does not commonly become very rarefied; the doors and windows in such places are not usually fitted with too much care to exclude air; they consequently do not suffer from an evil mentioned before, and the pressure of air below we may therefore assume to be usually sufficient. It has been shown before, that the effect of a contracted fire-place is to prevent currents of air from driving puffs of smoke into a room, and to give consistence to the column of heated air rising from the burning fuel.

It has also been shown, that a current becomes so accelerated in long chimneys, that such current requires to be checked. Now, if we apply these considerations to a short chimney, we shall see, that what is calculated to check the current in a long chimney, is useless in a short one, where a current is not easily attained at all; but, whatever is calculated to develope and increase the current in a long chimney, should be applied to the short chimney in a much greater degree. A regulating valve, where there is little or no upward current, and generally a reverse one, is therefore practically useless, unless it is possible for a good upward current to be established. It would therefore generally be left wide open. What is wanted is something of exactly the opposite nature; viz. means of establishing or increasing the current, and this is gained simply by an extension of the principle of contracting the fire-place. If, to a contracted grate, a sliding curtain or blower is used, as shown in fig. 3, an upward current is instantly improved if the fire is already burning. The reason why an extra contraction of the fire-place greatly increases the ascensional force of air from the fire, is as follows. By partly closing the space between the bars and the chimney, we reduce the amount of air that can readily find access to the chimney from the room, and the air in the space over the fire, which is temporarily closed in front by the blower, becomes highly rarefied. The warmer this space becomes, the more the air presses from the room into the chimney, and, as this air is obliged to pass in near contact with the fire over and between the fire bars, it attains a considerable temperature. The rush of air rapidly increases; the burning of the fuel is accelerated by the rapidity of the air; the fuel in turn acts with increased intensity in heating the chimney, and an upward current becomes thus easily established, where none before existed. Though,

however, an upward current can, under very many circumstances, be created by such powerful means as a blower, the advantage is not gained without extravagance of consumption; little heat where it is most desired, and the use of a contrivance which might from inattention be greatly misused. A very great improvement, however, can be made by reducing the height of the fire-place. If the top of the opening is lowered to about twelve inches from the top bar of the grate a blower is less required. And it must be borne in mind that the only heat which can be considered to be lost by this practice is that radiated by the upper part of a grate, which is not considerable. Fig. 5 represents one of the abominable structures in metal with a large open space above, such as is commonly put into a labourer's cottage and into the attics of larger houses. Fig. 6 represents the same fire-place contracted, with the fire bars only of metal; with fire bricks to form the back and sides, and pieces of slate or other material to reduce the size of the opening. The former fire-place could seldom or never be used without the nuisance of smoke; the latter, with the aid of a piece of iron to cover part of the fire-place in front at the time of lighting the fire would, generally, of itself be a sufficient cure from smoke, and it is no figure of speech to say, that it would give about twice as much heat as the other from the same consumption of coal.

A short chimney can be further improved by reducing it in size. The less the size of a chimney, the less the quantity of cold air it contains, and, therefore, the more easily that air is heated, and the greater the force with which it moves. But, in reducing the size of a chimney, it is most important that ample space should be left to carry off a body of air, sufficient in volume to remove the smoke and offensive gases resulting from combustion. If the chimney be reduced to about the size of the fire itself, it will be more than sufficient, and, in a small room,

nine inches by four and a half inches will be found ample.

To reduce the size of a chimney would be, however, rather a troublesome and expensive operation, and, it may be well, therefore, to point out how the object aimed at may be effected, in a considerable measure, by simpler means. Fig. 15 is a sketch of a metal tube, measuring in the upper part nine inches by four inches and a half, and in the opening below nine inches by seven inches and a half. If this be applied to a short chimney, just above the grate, and out of the sight of a person sitting, and if the opening to the chimney be closed so that no air can pass except through the tube, the lower part of the chimney will be effectually reduced in size, and the heated air will therefore have the consistence and force so necessary in a short chimney. If, also, the top of the chimney be reduced, by some very simple method, to the same dimensions as the small part of the tube, the chimney will become nearly as efficient as if reduced to the same dimensions throughout.

Fig. 15* represents an iron frame, with an opening of the same dimensions as the lower part of fig. 15, without its projecting rims, which could be built into the chimney. To this, the funnel-tube could be attached from below by means of turnbuckles, made to enter corresponding holes in the rims of the tube and the frame. This would enable the tube to be removed with facility for the purpose of sweeping the chimney or removing any soot that might fall around it.

It would be a troublesome matter to apply a regulating valve to the tube; and, as such an article would generally be practically useless, in consequence of there being no considerable current to be checked by it, its use might be dispensed with in short chimneys.

When a chimney is heightened considerably, it becomes immediately more serviceable. The down current becomes less intense, and can with greater facility be converted into an upward current; but, as

a remedy, it cannot be depended upon alone. When a chimney is heightened by a zinc flue, for instance, which is the mode usually adopted, this flue is acted upon by the external air; and, when a fire is extinguished, the upward current is rapidly checked and converted into a downward current, which has, perhaps, to be reversed with difficulty the next time a fire is required. As, therefore, a heightened chimney is followed by uncertain results, and is generally very unsightly, it is far preferable to improve a short chimney by reducing it in size, or by reducing the apertures of ingress and egress; and, also, by giving such attention to the fire-place as will not only render it easy for an upward current to be developed, but will be followed by excellent results in warmth and economy.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Chimneys in London are usually built in party-walls, and are not therefore exposed to be cooled by the action of air except from the inside; but, a chimney in an external wall has exposed brickwork, which becomes damp and cold unless constantly defended by a heated current. As the thermometer falls, the exposed brickwork becomes reduced in temperature. It cools by contact the air in the inside, and as soon as such air becomes colder, and therefore heavier, than the air in the apartment below, a downward current ensues which becomes accelerated the more the cooling influence increases. Such a chimney may be improved by simply increasing the thickness of the brickwork on the exposed side. This is the most obvious, and, undoubtedly, the best remedy; but it is of course attended with rather considerable expense. The brickwork should be increased from

four and a half inches in thickness, which it frequently is, in such a position, to nine inches.

The next remedy is at the fire-place. As the difficulty to be encountered is exactly the same as in a short chimney, viz. to convert a downward current into an ascending one, it is equally essential that there should be reasonable access for air to the room, by doors and windows, and that the space between the bars and the chimney should be temporarily reduced by a blower to enable a body of air to become speedily warmed.

As in the former case, the opening of the fire-place may be reduced in height and the dimensions of the chimney itself may be reduced, or merely the two extremities. In applying the latter remedies, however, great caution is required. It is better that a chimney should be too large than too small, for, if the products of combustion cannot pass away with sufficient freedom, a portion will inevitably enter the room. The funnel-tube, fig. 15, will do very well for a small room, and it may be adopted on other occasions, simply by making it of wider dimensions throughout than nine inches. If, in any case, it be made a little less in width than the width of the fire chamber, so that it can be placed or removed without difficulty, and if the dimensions of four and a half inches above and seven and a half inches below be retained, there will in all ordinary cases be ample facility for the escape of smoke. It need hardly be mentioned that the particulars given are not of absolute necessity, and that the funnel-tube can be modified in a great measure according to requirement. It may be made of less height, and the sides may slope instead of being at right angles with the front and back, if such an arrangement will render it better adapted for the fire-place.

If the external chimney is from a dining room, or a drawing room, a preferable grate may be used to that shown in Fig. 4. In Fig. 8 is shown a grate known

as Stephen's Patent. This has a very contracted form, but the contraction is behind the fire instead of in front of it. The current from the fire passes through a small door at the back of the grate, and, as the air becomes highly heated by passing over the burning fuel, an upward current can be quickly created and increased. The end gained is the same as by Fig. 4; but, there is this advantage in the Stephen's grate, that a good current is gained, at less cost, in consequence of the surface of the burning fuel, both at top and in front, being fully exposed to the room, even when the aperture to the chimney is most contracted. The door moves backwards and forwards on a hinge; but, in another grate, known as King's Patent, it moves up and down, being balanced by means of chains and weights. The latter description of door is most effectual for increasing or checking the draught. Both Stephen's and King's grates are admirable for several reasons. They give a very cheerful fire, look well, and they effectually warm large rooms; but, when properly made, they are more expensive than others, and they are not the most economical in use. The question, whether it is preferable to use such a grate, or to improve the construction of the chimney, can be decided immediately by reflecting that an upward current may not be created *instantly* by the grate, and that the aid of an open window may possibly be required, for a few seconds, in some instances; but, if the chimney be improved, it may become, practically, as useful as one situated in a party-wall, with which any well-constructed grate can be used. An external chimney in a wall facing the south or west is, for an obvious reason, less difficult to deal with than when the wall faces the east or north.

Cause 6.—From a chimney being exposed on two or three sides to the action of the external air, and the brickwork not being sufficiently thick.

This is an extension of the last evil, and the remedy is, therefore, a matter of greater difficulty. When a

chimney is built in the angle of a wall, with two sides exposed, or against a wall, with three sides exposed, and when the brickwork is no thicker than four and a half inches, the case constitutes, frequently, one of the most inveterate smoky chimneys that are encountered. The contracted fire-place and a sufficient supply of air are indispensable, and the chimney can be reduced in size at each end; but, the only truly effective remedy is to reconstruct the chimney with nine-inch brickwork.

Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.

This is a very difficult case, and generally comprises most of the ills of suffering chimneys. If, in public buildings, such as the Crystal Palace and St. James's Hall, there are apartments, or offices, with low chimneys, communicating immediately by doors with the main body of the building; whenever the air in this is more rarefied than that in the offices, air flows from the latter into the former as naturally as cold air enters a warm room by an open window. As the air passes from the room, colder air enters round the window and descends the chimney. We have in such a case a strong descending current, an external chimney, a low chimney, and one probably affected by wind, in consequence of its being below higher buildings, a cause which will be discussed further on. Every cause should be dealt with by itself. Air may be prevented from flowing into the main building by carefully fitted double doors. If the room be well supplied with air from special sources there will be a proper pressure to assist the upward current. The most contracted form of grate can be used. The external chimney and the low chimney can be improved by the means already indicated, and, finally, the descent of wind on the top of the chimney can be met by a simple protec-

tion. It will often be of lesser consideration to heat such places by means of hot-water pipes than to attempt the rectification of the fire-places and chimneys.

The same difficulty is often encountered in a private residence. A man builds an extra room at the back or side of his house, which he hopes to use for his dining room or library. He builds a short chimney, and when the air in his house is rarefied, cold air descends his chimney like a plummet, rendering it impossible for a fire to be used on most occasions. He should see that his house is reasonably supplied with air; fit his door of communication closely, or use a double door; give a special supply of air to his room; use a contracted grate; reduce the apertures of his chimney according to the instructions already given; heighten his chimney, if it can be done inoffensively, and place a protection on the top against the descent of wind.

Those intending to make such an addition to their houses in future, would do well to build their fire-place against their outside wall, and to construct a good chimney of the extreme height of their main building.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

A descending current in a chimney takes place whenever the air in a house or room is more rarefied than that in the chimney itself, and, on smoke emerging from an adjoining chimney, it returns to the house in the down current. The evil is sometimes remedied by increasing considerably the height of one of the chimneys, not, surely, an agreeable sight. If the room be duly supplied with air, a downward current will be far less frequent, and may possibly never occur, when fires are in use; and, if the regulator be used, shown in Fig. 3, the chimney may at any time be carefully closed.

Cause 9.—From the top of a chimney being situated below a pitched roof.

In the previous sections, the difficulty to be encountered has been a down current in a chimney, but, we come now to a class of cases which are entirely different, and in which the obstructing agent is the wind. A pitched roof is a source of obstruction to the wind which strikes against it, and often rebounds upon a chimney situated below; or the wind, passing over the pitched roof in rushing to more rarefied strata of air on a lower level, strikes violently the ascending current of air from a chimney and drives it back with the smoke in spite of any protection there may be to the top of the chimney. An effectual remedy is to raise the height of the chimney above the obstructing agent. It is far better to do this by means of brickwork, which can be particoloured in ornamental buildings, and surmounted by an ornamental chimney-pot in earthenware, than to use a tube of zinc or other metal.

In modern dwelling houses, it is usual to build the chimney stacks very low, sometimes scarcely as high as the roof, and consequently all the chimneys are found to smoke a little when the wind is in such a quarter as to be likely to descend from the roof upon them. In this one particular, we have certainly not become wiser than our forefathers. The houses in Bloomsbury, for instance, have chimney stacks carried completely above the roofs of the houses, and the evidence of sight may convince us that they can have few smoky chimneys. If the builders of our modern dwellings will carry their chimneys sufficiently high we need never fear that we shall see them terminated by unsightly appendages.

Fig. 10 is a sketch of the roof of the Middle Temple Library. The pressure of air flowing over the high-pitched roof was often so great that the chimneys were practically useless, even with the fire-places well

constructed. Ultimately, after a great deal of trouble, the chimneys were stopped above, and, metal flues, connected with them below, were carried up the sloping roof, as shown at *b, b, b, b*. Fig. 11 is submitted as exhibiting a reasonable suggestion for encountering the evil. By closing carefully the chimneys on the side nearest to the roof; by placing a simple protection at top, and providing a place of escape for the smoke on the opposite side only, it may be supposed that the smoke would escape without obstruction from any wind that may flow over the roof. If the wind is supposed to act in the opposite direction, as shown on the left side of the section, a shield, *c*, would probably be an ample protection.

Cause 10.—From the top of a chimney being situated near to a tower or similar source of obstruction to the wind.

This is another cause of an inveterate smoky chimney. A tower is usually an ornamental structure, but sometimes more ornamental than useful. If it is situated in close proximity to a chimney, this often smokes. The wind strikes the tower and rebounds on the chimney, or, if the wind comes from an opposite direction, and gains, by any means, a downward tendency, it prevents the smoke from emerging, as in the last case. The difficulty is often complicated by the chimney top being situated below a pitched roof, the chimney being in an external wall, and perhaps very short. Every cause must be, of course, dealt with. The fire-place should be treated in the manner found necessary for short chimneys; the thickness of the exposed brickwork should be increased, if insufficient, and the improvement can be considered admissible; the chimney should be carried above the height of the sloping roof, and, lastly, a protection, but of a very simple nature, should be furnished to the top of the chimney. The simplest and most obvious form of protection against a violent descent of air is a sloping

roof, as shown in fig. 12, which could be constructed of earthenware.

Cause 11.—From a short chimney being enclosed on three or four sides by high contiguous buildings.

Masses of cold air flow over the tops of our houses and descend into our streets and other open spaces. When there is a low chimney, as in the case stated, the pressure or force of the descending air is often so great as to overpower the upward pressure of the air escaping from the chimney, and a downward current ensues, totally regardless of any contrivance there may be on the top to prevent it. The evil may be most effectually remedied by building a chimney against an adjoining wall and carrying it above the roof. There may be a difficulty, however, in applying such a remedy, irrespective of expense; and, therefore, whatever means are calculated to improve the upward current may be used to diminish the evil. The due supply of air below, the contracted grate, the blower, the reduced chimney, the lengthened chimney within convenient limits, and the protection at top, will reduce the evil to a minimum that may cause annoyance at very rare intervals, if ever at all.

Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.

When masses of air flowing from hills to lower levels strike the backs of houses, a portion of the air may rebound upon low chimneys of outbuildings, or the wind may descend directly upon the chimneys, and, if the pressure of the flowing air is considerable, a very powerful descending current sometimes ensues, rendering it quite impossible for a fire to be kindled. In such a case there can hardly be a choice of remedies, and the judicious course is to meet the evil at once, by building the chimneys against the back walls,

of the extreme height of the main buildings. If, however, the chimneys are at some distance from the houses, the remedies for short chimneys can be adopted. The evil cannot, in that case, be of the utmost severity.

Cause 13.—From chimneys of one house being lower than those of one adjoining.

If the wind in passing over the roofs of houses strikes one of greater elevation, it rebounds upon contiguous chimneys that are below. In such cases a protecting roof to chimneys, as fig. 13 or 22, will be found indispensable.

Cause 14.—From a chimney being too small for the fire-grate used.

This is quite a modern cause for an ineffective chimney. Many persons have considered that our chimneys are too large, and, without considering the question with sufficient fulness, have unfortunately given dimensions for the construction of chimneys much too small. The best grate for a small chimney is that which allows the least air to escape, viz. the contracted description before referred to. But, if the chimney is too small for any ordinary grate, we may suppose of six-inch drain pipes, there is no remedy but to use stoves that require far less air than open fire-places, or to re-construct the chimneys of more suitable dimensions.

Cause 15.—From two fire-places being used with one chimney.

In ordinary fire-places, a considerable body of air passes up the chimney, and, when an opening is made in the chimney, and another fire-place is constructed, it is found that the chimney is not of sufficient capacity for the escape of the two columns of air. One of the fire-places is therefore useless, and smoke

returns to the room. The proper remedy is to diminish as much as possible the quantity of air that can pass up each fire-place by means of contracted grates, and the regulator shown in fig. 3, which should never be opened more than necessary for the free escape of smoke. A chimney that was only sufficient for one grate will thus suffice for two. It is also very essential that there should be no deficiency of air in both rooms.

A descending flue is often carried into a chimney which is required to answer another purpose; but to enter upon this matter would entail a discussion of the whole subject of descending flues, which should form part of a treatise on close or pedestal stoves.

On kitchen fire-places.

The last of the enumerated causes for a smoky chimney having been noticed, it will be well to say a few words on the application of the foregoing principles to kitchen fire-places. An old fashioned kitchen range, it is well known, has a large open fire-place, with a yawning chimney immediately over. Such a fire-place can be contracted in the manner shown in figs. 16 and 17. The openings above the hobs leading to the chimney should be entirely closed, and two upright pieces, *a, a*, fig. 17, shown by dotted lines in fig. 16, should confine the passage to the chimney at each side. A piece of iron, *b*, placed across in a sloping direction, and fastened at each end to the two side pieces, will act as a check to the quantity of air that can press to the chimney from the room. The air in the chimney would become in consequence far more rarefied, and the air which passes over the fire and enters the chimney, would have, therefore, far greater ascensional power than before. A blower, *c*, will assist to contract the open space, and if an opening, *d*, be left at the top of the sloping plate, any smoke rising directly from the fire will readily escape.

A kitchen is usually abundantly supplied with air, but, there is an impediment peculiar to such a place of very common occurrence. Our builders are generally judicious enough to provide our kitchens with chimneys of sufficient capacity to carry off the considerable quantity of warm air which we discharge into the atmosphere; but, it is no uncommon thing to find that the escape of the air and smoke is checked by a very small chimney pot being used, as a fitting termination, to a large chimney. The upward force of the air being greatly checked, the external cold air often prevails, enters the chimney and drives back the smoke. A chimney pot to a kitchen should not be less than twelve inches in diameter in the inside.

The article termed a kitchener, now very commonly used instead of an old-fashioned kitchen range, has become very well known within a few years. The upper part of the fire-place is entirely closed, and the usual passage from it to the chimney is by flues round the oven and boiler. The kitchener is scarcely ever known to smoke, even with a very low chimney, which is to be accounted for by the fact, that it sends so considerable a volume of highly heated air into the atmosphere, as to overcome by its force any pressure of an opposite nature. This extravagant mode of rectifying a defective chimney pronounces strongly against our economy of heat in kitchen fire-places.

Mr. Billing's Terminals for Chimneys.

This little treatise would be decidedly imperfect without an examination of the mode of finishing the tops of chimneys which was introduced by the late Mr. Billing, and which has been of late somewhat extensively applied. Fig. 20 represents a piece of earthenware, which is placed at the top of a chimney for the purpose of considerably reducing the aperture by which the smoke can escape; and fig. 19 another piece of earthenware, used to form a division between

two chimneys, or to enclose a chimney on two sides. Both articles are shown in position in fig. 21. In fig. 18 the division piece, a little different in form to fig. 19, is seen to terminate the chimney stacks, the ordinary chimney pots being, of course, dispensed with. The author is not aware what is the real nature of the benefit claimed to arise by the use of these simple contrivances, and he will, therefore, endeavour to examine in what way they appear calculated to affect, or to improve, the action of a chimney.

It has been seen that when a downward current exists in a chimney, and smoke issues from one adjoining, that this smoke occasionally passes into the downward current, and descends to a room where there is no fire burning. It has been pointed out that the evil can be remedied by supplying the room in which the nuisance occurs, a little more freely with air, that the descending current may be checked, or converted into an upward current; and, that a convenient and effectual means of closing the chimney may be of service on such an occasion. The evil may, however, be met by such a contrivance as fig. 19. If this division piece be placed between two chimneys at top, the air and smoke issuing from one will pass off at the sides which are not blocked, and a descending current in an adjoining chimney will, with considerably less probability, carry smoke with it. But, returned smoke in a vacant fire-place is not a common evil, and, as the other means indicated for avoiding it are such as improve the condition of habitable rooms and the effectual working of a fire-place, they may be considered the preferable. The division piece may answer, however, a more useful purpose. No chimney stack can be left with a flat surface at top. The old chimney pot had its use in breaking the force of the wind, and, if the division piece is found to answer the same purpose as effectually, it may be used as a substitute for an old form.

The first effect which a reduction of the aperture at

the top of the chimney, by fig. 20, appears calculated to produce, is to check the ascent of the heated column of air. That it does so, may be considered evident from the fact, that a partial closing of the regulator or register in the fire-place, checks the quantity of air that can enter the chimney. In a water pipe or a gas pipe a check of the same description greatly diminishes the force and quantity of the issuing air or liquid. At the top of a chimney the same causes operate as at the bottom, though different in degree. There is the air expanded by heat, the pressure upwards from below, and the resisting medium above; and, there appears to be no other difference between the check at the top of a chimney and the one at bottom, than that the former is permanent, but that the latter can be used or not at pleasure. As, however, it has been shown that it is often advisable to establish an upward current in a fire-place with some rapidity, for the purpose of effectually carrying off the smoke, which current should be diminished as soon as the object has been gained, the check to be used or not at pleasure may be considered preferable to the permanent one.

There is, however, another aspect of the case. Are our chimneys of the most useful dimensions for performing their office, or are they invariably too large? If they are too large, is it not useful to diminish the size at top, for the purpose of preventing as much as possible the entrance of cold air, and to offer as small a surface as possible to the action of the wind? The only answer to this question must certainly be in the affirmative; but, anything more than this simple admission should entail a discussion of the whole subject relative to the best dimensions for chimneys. This can be more properly dealt with in a treatise addressed particularly to our architects and builders; but, it will be sufficient for our present purpose to remark, that the dimensions of a chimney should necessarily correspond to the quantity of air it is re-

quired to remove, which again depends on the size of the fire and the description of grate in use. As our chimneys are almost universally of the same dimensions, it follows, that what is sufficient for one apartment is much more than sufficient for another. A chimney from a small fire, with a contracted grate, may be greatly reduced; but, one from a large fire should be dealt with very cautiously. We may therefore consider that the article, fig. 20, is of benefit in all cases when the aperture is fully sufficient to remove the heated air, gases, &c. which may at any moment be ready to escape. If, on the contrary, it be used at any time with an aperture insufficient in size, the checking of the upward current will enable the pressure of the air above to prevail; cold air may enter the chimney and the products of combustion be driven back. The contrivance, therefore, should be used with caution to existing buildings; but, with reference to buildings yet to be constructed, demonstration is hardly necessary to prove, that its use should be superseded by the chimneys being constructed of the dimensions which are best adapted to answer their intended purpose.

We may now ask whether or not the division plate and a reduced aperture can serve a purpose of protection against wind. It has been, we hope, amply proved that chimneys only require such protection when their tops are below something contiguous and of greater elevation, by means of which a descending power is given to the wind. If we look at the sketch, fig. 21, it will hardly appear that the division plate can often protect the aperture for the smoke. What is wanted in such a case is a simple roof, as in fig. 22, which was put to a house in Park Village, Regent's Park, on its construction many years ago.

Concluding Observations.

The above causes probably account for ninety-nine per cent. of all the smoky chimneys that exist, and, it is doubtful, indeed, if there be any other that is

not almost identical with some one of those described. It will now be evident to any person unversed in such matters, who may have given the preceding observations a little careful consideration, that the idea of there being any universal cure for a smoky chimney is very preposterous, and can only have arisen in the minds of those who have not pursued any investigation upon a scientific basis, or whose experience in such matters has been of very limited extent. Though, however, the causes for a chimney smoking are various, they all proceed from a disregard of general principles very few in number. For the sake of perspicuity, every distinct cause has been stated and examined by itself, and it is hoped that the particulars given are sufficient to indicate what are the very few cases of real difficulty, and to enable a person of intelligence to decide upon, and to apply, an appropriate remedy in any instance in which he may happen to be a sufferer. Though, however, the distinct causes are numerous, and the remedies various, it may be shown that the whole question is involved in very great simplicity.

The fifteen causes mentioned may be placed under three divisions, as follows—

First Division.

Chimneys that smoke in consequence of a descending current existing, or being produced in the chimney.

CAUSES.

Cause 1.—From a fire-place being too open.

Cause 2.—From the doors and windows of a room being fitted too closely.

Cause 3.—From fires being lighted in two or

REMEDIES.

To contract the size of the fire-place, or use a contracted grate.

To supply air by means of doors and windows, or by means of a special supply near to the fire.

To contract the opening into the chimneys.

CAUSES.

three adjoining rooms, which are inadequately supplied with the air required by the grates in use.

Cause 4.—From a chimney being very short.

Cause 5.—From a chimney being situated in an external wall, and not being sufficiently protected against the action of the external air.

Cause 6.—From a chimney being exposed on two or three sides to the action of air; the exposed brickwork not being sufficiently thick.

Cause 7.—From a low chimney being in connection with a room adjoining a house or building in which the air becomes rarefied.

Cause 8.—From a down current in a fire-place bringing smoke from an adjoining chimney.

REMEDIES.

To give an additional supply of air. To use grates that will not allow much air to ascend the chimneys.

To use a contracted grate with a blower. To reduce the height of the fire-place and the size of the chimney. To lengthen the chimney. To reduce the opening into the chimney at bottom and at top.

To improve the construction of the chimney. To use a very contracted grate. To reduce the opening into the chimney at bottom and at top.

To improve the construction of the chimney.

To supply the house and room liberally with air. To fit tightly the door of communication, or use double doors. To use a contracted grate. To heighten the chimney. To reduce the size of the chimney.

To supply the room properly with air. To use a carefully fitted regulator to the chimney.

Second Division.

Chimneys that smoke in consequence of a descent of wind.

CAUSES.

Cause 9.—From the top of a chimney being situated below a pitched roof.

Cause 10.—From the top of a chimney being situated near to a tower, or similar source of obstruction to the wind.

Cause 11.—From a short chimney being enclosed on three or four sides by high contiguous chimneys.

Cause 12.—From rooms with short chimneys being situated between the main body of a building and a contiguous eminence.

Cause 13.—From chimneys of one house being lower than those of one adjoining.

REMEDIES.

To heighten the chimney that its top may be above the source of obstruction.

To heighten the chimney. To use a simple protection, as fig. 12.

To heighten the chimney. To put a simple protection at top. To use the most contracted grates, and supply air below in moderate abundance. To reduce the size of the chimney or the extremities.

To build the chimneys of the extreme height of the main building. To use the remedies indicated for cause 4.

To heighten the chimneys. To put a protecting roof, as fig. 13 or 22.

Third Division.

Chimneys that smoke in consequence of their being too small.

CAUSES.

Cause 14.—From a chimney being too small for the fire-grate used.

Cause 15.—From two fire-places being used to one chimney.

REMEDIES.

To use a grate that will allow a minimum quantity of air to ascend the chimney. To re-construct the chimney. To use a stove.

To use well-contracted grates, with carefully fitted regulators. To supply rooms sufficiently with air.

It is seen by the above table that nearly all our smoky chimneys are occasioned by two general causes, viz. the natural descent of cold air in a chimney, and the fall of wind on the top of a chimney, caused by some neighbouring obstruction. The third general cause is very rarely encountered. We can now make some interesting reflections relative to the mode which has usually been adopted for the prevention of nuisance by smoke. What has been a source of perplexity to thousands, nay hundreds of thousands of persons, has simply been, that they have entirely confounded the first general cause with the second, both being, in fact, entirely distinct, and to be encountered by different remedies. If the natural descent of air in a chimney be reversed by some of the various means indicated, the wind itself will be found to be, by no means, the difficult subject to deal with that is generally supposed, and the thousand various forms which have been invented to wile away, or to protect against, the wind, may, to the benefit of the national taste, pass quickly into oblivion. A few of the amusing forms, however, will be preserved in the pages of the lamented Mr. John Leech, where he gives his celebrated Mr. Briggs amazed and delighted at his builder's operations on the roof of his house. We have seen that chimneys are only affected by the wind when they are

situated below something contiguous, as a roof, a neighbouring stack of chimneys, a higher house or neighbouring hills, and that, therefore, chimneys in general do not require any protection whatever. It can, in fact, be proved, by overwhelming evidence, that when bodies of air move unobstructed over our heads on the same plane as the horizon, they do not affect our chimneys in any appreciable degree. We have only to look around us, and we shall see that the number of chimneys to which it has not been considered necessary to apply a protection, is by far the most considerable, and that, in many recent buildings, no trace whatever of such a thing is to be found. Fig. 18 represents a portion of the roof of the National Provident Institution, from the designs of Professor Kerr, in which the chimneys are raised high, as they should be; and fig. 14 the roof of Montagu House, Whitehall, in which the same precaution has been taken. A most excellent example is the Charing Cross Railway Station and Hotel now being completed.

Recommendations to builders and others for the avoidance of smoky chimneys in new buildings.

Rule 1.—To use grates of a contracted form, fitted with proper regulators, and to avoid grates with hobs.

Rule 2.—To avoid fitting doors and windows so as to practically exclude fresh air from a room; or to give a special supply of air near to a fire, in sufficient quantity, for which particulars have already been given.

Rule 3.—To build chimney stacks in all cases as high as the highest part of the roof, and to terminate them by chimney pots, or by Mr. Billing's division piece.

Rule 4.—To terminate a chimney stack by a projecting roof, as fig. 13 or 22, whenever a building is lower than an adjoining one, or whenever the chimney

stack of one house is lower than a contiguous one of a house adjoining.

Rule 5.—To build all chimneys that are exposed on one side, or more, of nine-inch brickwork.

Rule 6.—To build all short chimneys of smaller dimensions than usual. Nine inches by four and a half inches are sufficient for ordinary attic fire-places and labourer's cottages.

Rule 7.—To construct the fire-place of a low chimney not exceeding thirty inches in height.

Rule 8.—In constructing an extra room with immediate communication from the main building: to build a good chimney, if possible, against the main building, and terminate it as by Rule 3.

Rule 9.—When it is impracticable to build a lofty chimney against the main building, to construct the chimney no larger than amply sufficient: to use a contracted grate, with a blower; to build the chimney as high as may be convenient; to construct a low fire-place; to give a special supply of air near to the fire; to place a protecting roof to the chimney; and, if the air in the house or building is likely to be generally more rarefied than the air in the added portion, to fit tightly the door of communication, or construct a double door. The last two rules are intended to avoid the causes 7 and 12.

It may be hoped it is now obvious, that by attention to such general rules as the due supply of air to houses and rooms; the use of contracted fire-places; attention to the proper construction of chimneys, and the use occasionally of some simple protection, smoky chimneys may be everywhere successfully dealt with, and rendered very unnecessary possibilities in the future. May it not also be considered evident, that elegance or neatness of form, need never be sacrificed to utility, and, that, if excellent designs are often marred by unsightly terminations to chimneys, this

is simply in consequence of two important subjects being unequally understood? None will be more thankful than our very useful body of architects to be relieved from unsightly nuisances; and, if, with minds already considerably practised on the subject, they should have their attention directed to these pages, the author's labour will not have been in vain, and he will have reason to be thankful that certain fortuitous circumstances have given him an opportunity to render one slight service to his country.

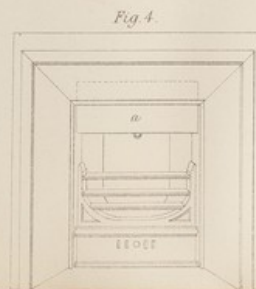
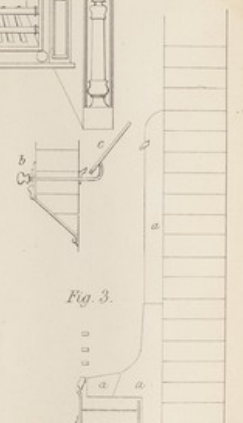
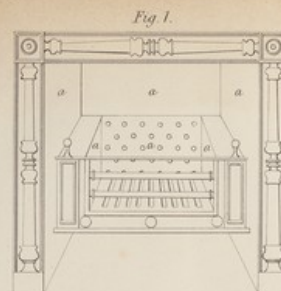
The question of the ventilation of our apartments, together with the utilization, to a considerable extent, of the heated products of our fires, and the most efficient construction of our chimneys, the author will, with much probability, discuss at a future period. He hopes to show that a true and effective system of ventilation need not interfere in the slightest degree with the due warming of our apartments, and, that, the more both subjects are understood, the better they can be harmoniously combined.

Fig. 1. An old-fashioned grate, made entirely of metal, with large space over the fire.

Fig. 2. A contracted grate: *a, a, a*, fire brick back and sides; *b*, handle of regulator to chimney opening; *d*, opening to admit fresh air.

Fig. 3. Transverse section of fig. 2: *a, a, a*, fire brick chamber; *b*, handle of regulator to chimney opening; *c*, regulating valve in chimney.

Fig. 4. Contracted grate with a sliding blower, *a*. The outer form shown in figs. 2 and 4 is not necessary. The more popular arched form for a grate is equally serviceable to contract the opening of the fire-place.



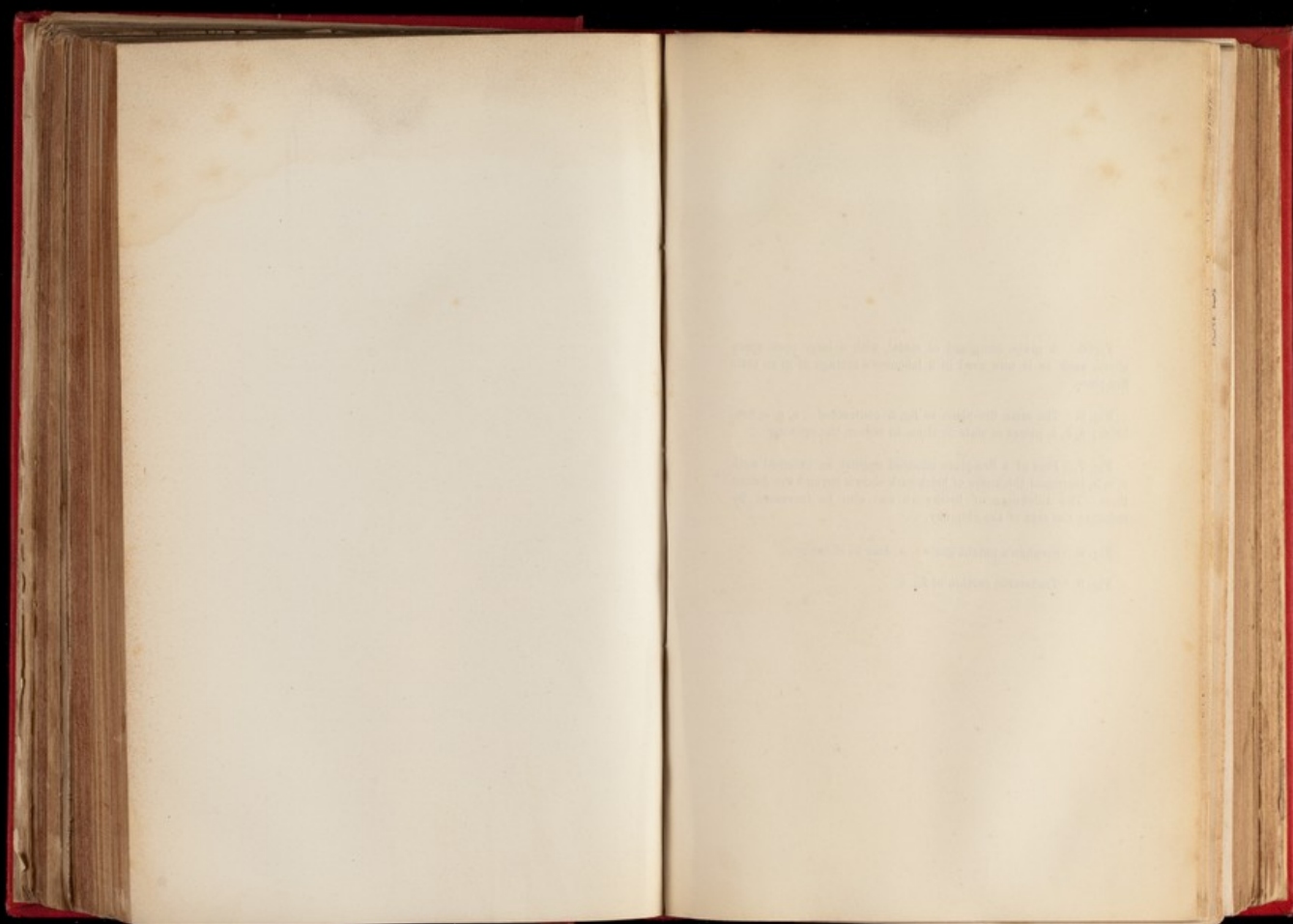


Fig. 5. A grate composed of metal, with a large open space above, such as is now used in a labourer's cottage or in an attic fire-place.

Fig. 6. The same fire-place as fig. 5 contracted. *a, a, a*, fire-brick; *b, b, b*, pieces of slate or stone to reduce the opening.

Fig. 7. Plan of a fire-place situated against an external wall. *a, a, a*, increased thickness of brickwork shown beyond the dotted lines. The thickness of brickwork can also be increased by reducing the size of the chimney.

Fig. 8. Stephen's patent grate. *a*, door to chimney.

Fig. 9. Transverse section of fig. 8.

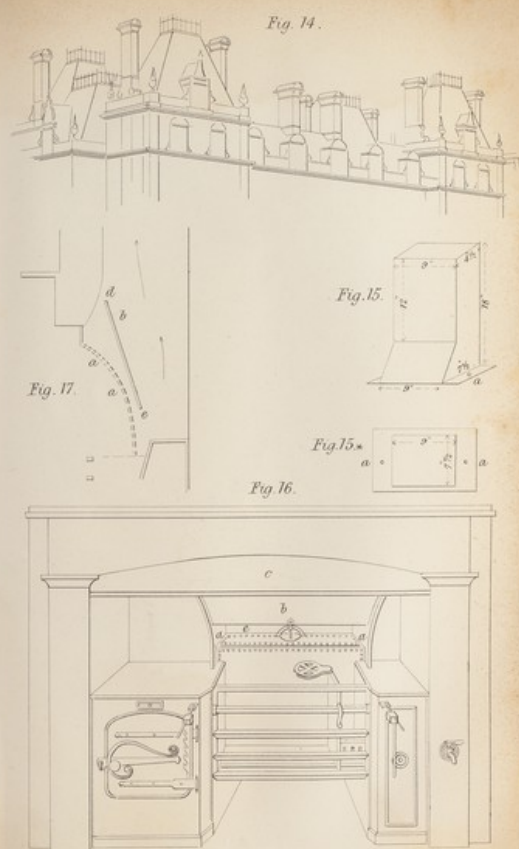
Fig. 14. Roof and upper portion of a mansion in Whitehall, erected from the designs of Mr. William Burn, showing the elevated stacks of chimneys. This sketch is taken from the *Illustrated London News* of September 24th, 1864. A portion only of the details are given here.

Fig. 15. A funnel-tube to reduce the opening into a short chimney, above the fire-place.

Fig. 15.* An iron frame to fix in a chimney above the grate, to which the funnel-tube can be attached by turnbuckles at *a, a*.

Fig. 16. An old-fashioned kitchen range with a blower, *e*; two side plates, *a, a*; and a front plate, *b*, to contract the opening leading to the chimney.

Fig. 17. Transverse section of a portion of Fig. 15, showing the inclined plate, *b*, and the openings to chimney, *e, d*.



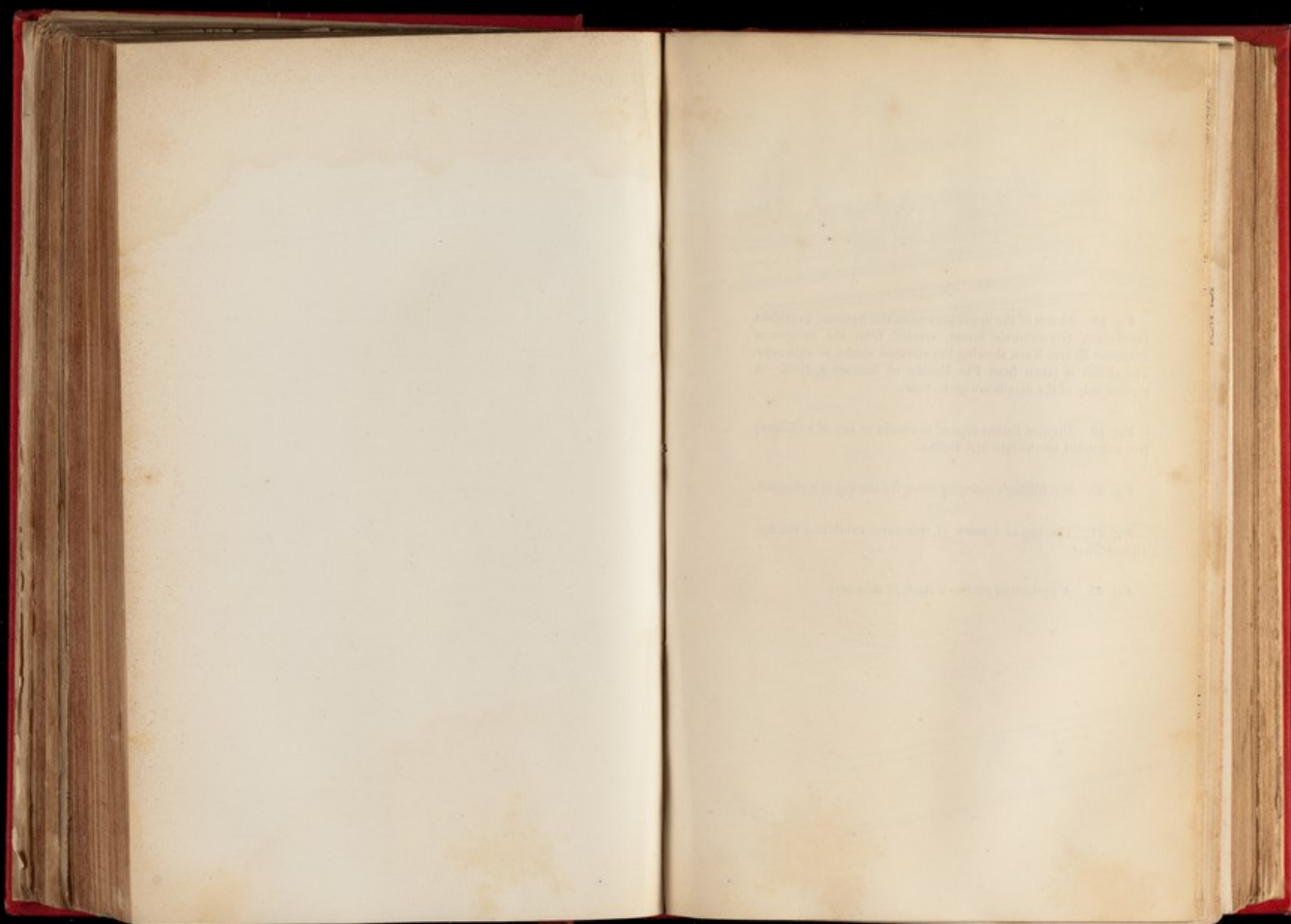


Fig. 18. Sketch of the upper portion of the National Provident Institution, Gracechurch Street, erected from the designs of Professor Robert Kerr, showing the elevated stacks of chimneys. The sketch is taken from *The Builder* of January 3, 1863. A portion only of the details are given here.

Fig. 19. Division for the tops of chimneys in lieu of a chimney pot, suggested by the late Mr. Billing.

Fig. 20. Mr. Billing's reducing piece for the top of a chimney.

Fig. 21. The top of a stack of chimneys, exhibiting the figs. 19 and 20.

Fig. 22. A protecting roof to a stack of chimneys.

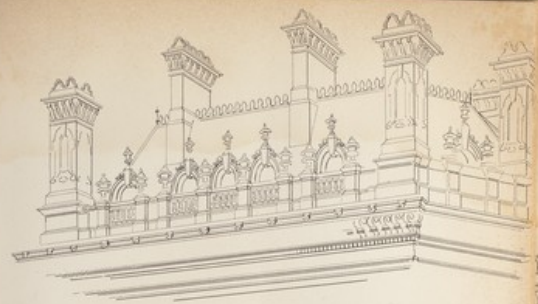


Fig. 19.



Fig. 20.



Fig. 21.

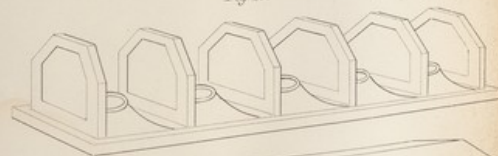


Fig. 22.

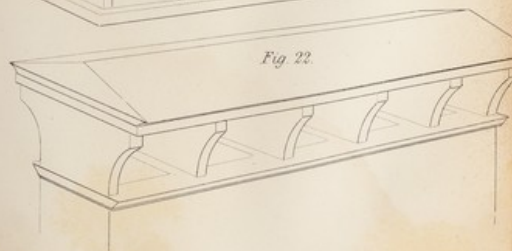


Fig. 5.



Fig. 6.

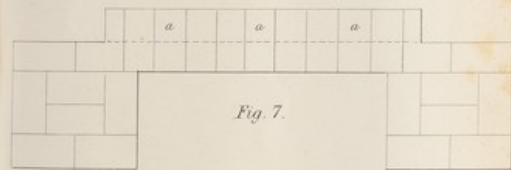
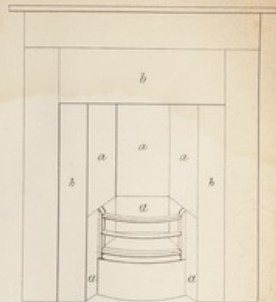
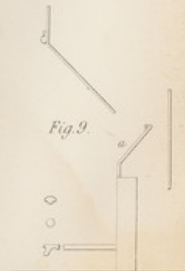


Fig. 7.

Fig. 8.



Fig. 9.



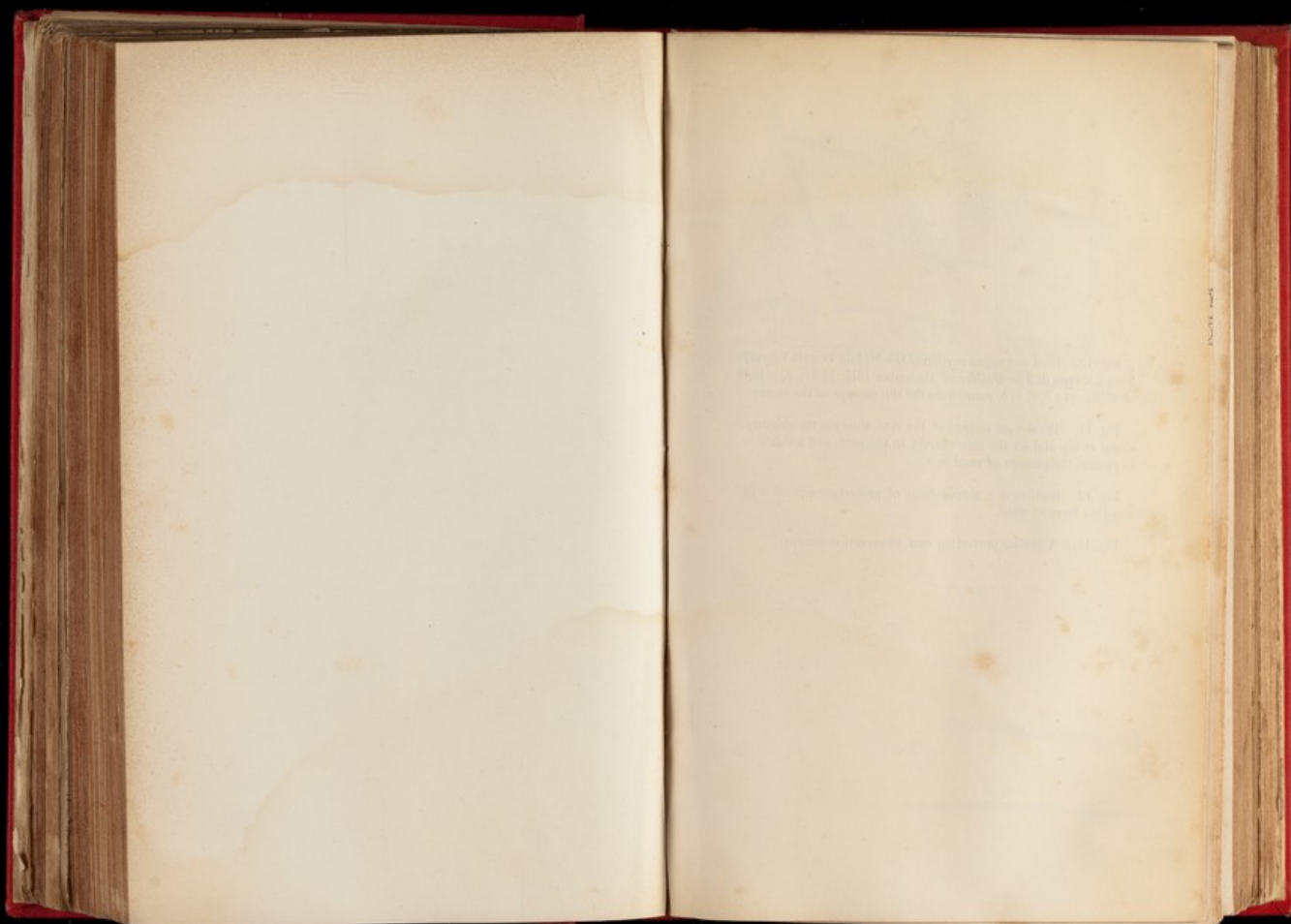
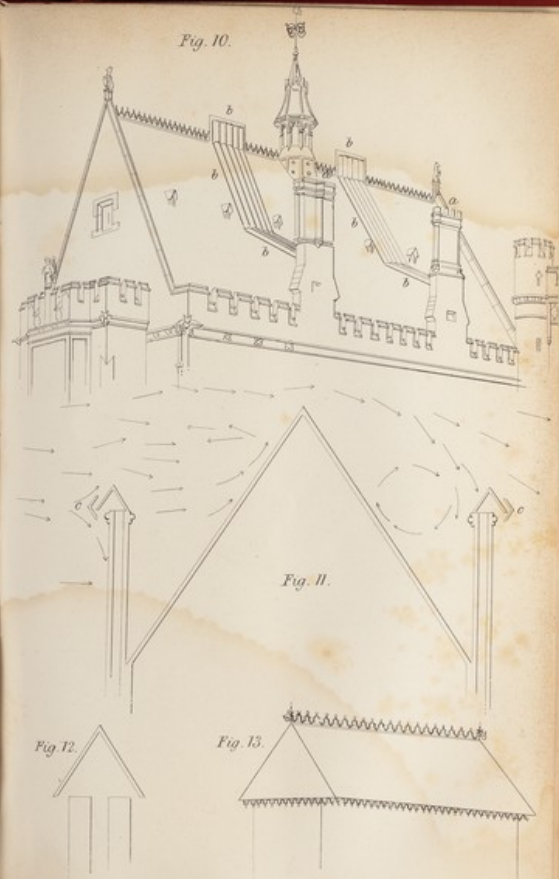


Fig. 10. Roof and upper portion of the Middle Temple Library, from a sketch in *The Builder* of December 15th, 1860; *a, a*, tops of chimneys; *b, b, b, b*, metal flues for the passage of the smoke.

Fig. 11. Transverse section of the roof, showing the chimneys closed at top and on the side nearest to the roof, and a shield, *c*, to protect the passage of smoke.

Fig. 12. Section of a simple form of protection against a descending force of wind.

Fig. 13. A similar protecting roof to several chimneys.



RESEARCHES
UPON
"SPURIOUS VACCINATION,"
OR THE
ABNORMAL PHENOMENA ACCOMPANYING AND FOLLOWING VACCINATION
IN THE
Confederate Army,
DURING THE RECENT
AMERICAN CIVIL WAR, 1861--1865.

BY
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versity of Nashville, Tenn.*

From the Nashville Journal of Medicine and Surgery.

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1867.

RESEARCHES

Upon "Spurious Vaccination," or the Abnormal Phenomena accompanying and following Vaccination in the Confederate Army, during the recent American Civil War, 1861-1865. By JOSEPH JONES, M.D., Professor of Physiology and Pathology, in the Medical Department of the University of Nashville, Tenn.

SECTION I.

PRELIMINARY OBSERVATIONS—ACCIDENTS ATTENDING VACCINATION AMONGST THE CITIZENS AND SOLDIERS OF THE CONFEDERATE STATES—NECESSITY FOR THE INVESTIGATION—METHOD, EXTENT AND OBJECT OF THE INQUIRY.

During the recent civil war, untoward results followed vaccination, and a number of deaths both amongst the troops and citizens were directly referable to the effects of vaccination. So great was the evil in the army, that it was made a special subject of investigation, and a number of interesting reports were prepared by several of the medical officers, upon what was most generally called in the army, "spurious vaccination." Our friend, Surgeon Jackson Chambliss, in charge of Div. No. 1 Camp Winder Hospital, Richmond, had examined and recorded a large number of cases of "spurious vaccination," illustrated with drawings of the various local diseases and skin affections. As far as our information extends, this valuable mass of matter, relating to one of

the most important subjects in its bearings upon the welfare of the human race, was destroyed during the evacuation of Richmond. If any of these reports are still in existence, we shall be happy to be the medium of communicating them to the profession.

So common had accidents become after vaccination, and so strong was the prejudice growing, both in the army and amongst citizens against its employment, that we instituted a series of experiments upon the inoculation of cows with small-pox matter, in order to produce, if possible, cow-pox, from whence a supply of fresh and reliable vaccine matter might be obtained. It was our design to carry out an extensive series of investigations upon the various secondary affections following vaccination, and to determine, if possible, what contagious principles could be associated with the lymph of the vaccine vesicle. These labors were brought to a sudden and unexpected close, by the disastrous termination of the civil war. As far, however, as our labors amongst the Confederate troops extended, we were led to attribute the injurious effects of vaccination to the following causes:

1st.—*Depressed forces, consequent upon fatigue and exposure and poor diet: impoverished, vitiated and scorbutic condition of the blood of the patients vaccinated, or yielding vaccine matter.*

2d.—*The employment of matter from pustules or ulcers which had deviated from the regular and usual course of development of the vaccine vesicle; such deviation or imperfection in the vaccine disease or pustule being due mainly to previous vaccination, and the existence of some eruptive disease at the time of vaccination. Or in other words, the employment of matter from patients who had been previously vaccinated, and who were affected with some skin disease at the time of the insertion of the vaccine virus.*

3d.—*Dried Vaccine, Lymph or Scabs, in which decomposition has been excited by carrying the matter about the person for a length of time, and thus subjecting it to a warm moist atmosphere.*

4th.—*The mingling of the Vaccine Virus with that of the Small Pox:—matter taken from those who were vaccinated while they were laboring under the action of the poison of Small Pox, was capable of producing a modified Variola, and comparatively mild disease in the inoculated, and was capable of communicating by effluvia Small Pox in its worst character to the unprotected.*

5th.—*Dried Vaccine, Lymph or Scabs, from patients who had suffered with Erysipelas during the progress of the Vaccine Disease, or whose systems were in a depressed state from improper diet, bad ventilation, and the exhalations from Typhoid Fever, Erysipelas, Hospital Gangrene, Pyæmia, and offensive suppurating wounds.*

6th.—*Fresh and dried Vaccine Lymph and Scabs, from patients suffering from Syphilis, at the time, and during the progress of vaccination and the vaccine diseases.*

The results of my investigations during the war, were published in the Southern Medical and Surgical Journal, July, 1866, pp. 165-180, under the head of "Spurious Vaccination."

Since the publication of this article, we have still farther investigated the subject, and addressed a large number of communications relating to "Spurious Vaccination" to southern physicians formerly connected with the Confederate Army, and the replies to these inquiries will be found in the following pages; and in truth, aside from the great interest and importance which everything relating to vaccination possesses, one of the chief objects which we had in preparing the present article, was to collect and consolidate and preserve the labors of southern physicians.

The following is the general form of circular employed:

NO. 7 NORTH VINE STREET, NASHVILLE, TENN. 1866.

M.D.

DEAR SIR:—

I am at present engaged in drawing up a monograph upon "Spurious Vaccination, and "Modified Inoculation."

In this paper, which will be published at an early day, I will endeavor to do full justice to the valuable labors of Confederate Surgeons.

In the circumscribed and distressed condition of the Southern States, cut off from the surrounding world, with the necessity of Vaccinating the entire male population capable of bearing arms, and without any means of obtaining fresh and reliable matter outside of the Confederate States, the experience of the Medical Officers of the Confederate Army possesses a high and peculiar value.

I shall be glad to receive from you a communication, setting forth your views at length upon the nature and value of Modified Inoculation, and upon the NATURE and CAUSES of the ACCIDENTS resulting from VACCINATION ("SPURIOUS VACCINATION") in the Confederate Army.

The subject of the TRANSMISSION of SYPHILIS through the medium of the VACCINE VIRUS, should be carefully discussed, and all conclusions should be supported by carefully recorded facts and cases. One well reported case, proving the transmission of Constitutional Syphilis, or any other disease, as Erysipelas, by vaccination, is worth large volumes of mere opinions and assertions.

We should exercise the utmost caution in discussing the value of vaccination, and the causes of the accidents, which have tended of late, to bring it into disrepute with the public; for all conscientious physicians and lovers of mankind will agree that this question is interesting, not only to the physiologist and medical practitioner, but that it concerns every community on the earth, and comes home to every individual of the human race.

It has been well said, by a writer who was not a medical man, "It is difficult to conceive that there should be one being who would not be affected by its decision, either in his own person, or by those of his nearest connexions. To the bulk of mankind wars and revolutions are things of infinitely less importance; and even to those who busy themselves in the tumult of public affairs, it may be doubted whether any thing can occur that will command so powerful and permanent an interest, since there are few to whom fame or freedom can be so intimately and constantly precious as personal safety and domestic affection."

It is important that we should carefully distinguish the accidents which result from carelessness in the selection of the matter, and from ignorance of the true character and progress of the vaccine disease.

You will oblige me by answering at an early day, and also by forwarding the address of any physicians who have made this subject a special study, and who have recorded trustworthy observations.

Very respectfully yours,

JOSEPH JONES.

This circular letter has not been as widely distributed as was desired; as it has been difficult to ascertain the address of many of the medical officers of the Southern Army, on account of the sudden manner, in which the struggle terminated, and the utter and sudden loss of all organization and records; and on account of the imperfect mail facilities of the Southern States.

Therefore, all who may receive this paper, are respectfully requested to consider themselves as addressed in person.

The replies which have been received in response to my letters, will be found under the different divisions of the inquiry; and we have preferred presenting each paper entire, when using it for the illustration of some particular branch of the subject, although it might contain some matter irrelevant to the subject under immediate consideration. In this manner we hoped to do entire justice to those contributing facts and observations; and whilst we have freely expressed the results of our investigation, and given our judgment without reserve, we have endeavored on the other hand to avoid all personal criticism. The replies to these printed enquiries will be published from time to time as they may be received.

Before proceeding to the discussion of the subjects under consideration, it is but just that I should disclaim all design of decrying vaccination when properly performed. Nothing is farther from my intention, than even in the remotest manner, to detract from the value of the greatest physical boon ever bestowed by a mortal upon the human race.

From authentic documents and accurate calculations, it has been ascertained that one in fourteen, of all that were born died of the small-pox, even after inoculation had been introduced; and of persons of all ages taken ill of the small-pox in the natural way, one in five or six died; and in addition to this frightful mortality, alike observable in all the different regions of the globe, many of those who recovered were permanently disfigured, or deprived of eyesight, or left with shattered constitutions the prey to pulmonary consumption, chronic ophthalmia and scrofula.

According to the researches of Black, Lüssmleth and Frank, eight or nine per cent. of the human race were carried off by small-pox: and Duvillard endeavored to show that of 100 persons, only four reached the age of thirty years without having it, that one in seven or eight, who were affected, died; and that of those who were attacked in infancy only two-thirds escaped. Before the introduction of vaccination, small-pox was infinitely more destructive to human life than the plague itself; it has

swept away whole tribes of savage and half civilized people, and its miserable victims have been abandoned by their nearest relatives and friends, as persons doomed by divine wrath to irrevocable death: it was calculated that 210,000 fell victims to it annually in Europe, and Bernoulli believed that not less than fifteen millions of human beings were destroyed by small-pox every twenty-five years, that is six hundred thousand annually: and this loathsome disease was not only universal in its ravages, but was so subtle in its influence and insidious in its attack, that all efforts to stay its violence or to prevent its approach, were utterly futile. Even inoculation whilst it was far less severe and fatal than the natural small-pox and thus benefitted the individual, tended nevertheless to increase the spread of the disease, and its extensive adoption was attended with a most marked increase of mortality of the disease in the human race.

Sir Matthew Hale in a letter of advice and admonition to one of his grandsons, has given an excellent picture of this disease, which well illustrates its odious characters, and exhibits the impression which it makes upon the world at large, in a stronger light than if the description had been drawn up by a strictly professional hand.

"First, therefore, touching your late sickness (small-pox) I would have you remember these particulars: 1st. The disease itself in its own nature is now become ordinary very mortal, especially to those of your age. Look upon even the last year's general bill of mortality, you will find near two thousand dead of that disease the last year; and, had God not been merciful to you, you might have been one of that number with as great likelihood as any of them who died of that disease. 2d. It was a contagious disease that secluded the access of your nearest relations. 3d. Your sickness surprised you upon a sudden, when you seemed to be in your full strength. 4th. Your sickness rendered you noisome to yourself and all that were about you; and a spectacle full of deformity, by the excess of your disease, beyond most that are sick thereof. 5th. It was a fierce and violent sickness: it did not only take away the common supplies of nature, as digestion, sleep, strength, but it took away your memory, your understanding and the very sense of your condition, or of what might be conducive to your good. All that you could do was only to make your condition more desperate, in case they that were about you had not prevented it and taken more care for you than you did or could for yourself. 6th. Your sickness was desperate, in so much that your symptoms and the violence of your distemper were without example; and you were in the very next degree to absolute rottenness, putrefaction and death itself."

By the unaided efforts of a man, emulous not of distinction but desirous of advancing truth, and promoting the happiness and well being of his fellow creatures, and distinguished as much for his humility, long suffering and perseverance, as for his unsurpassed powers of practical observation, the world has been furnished with the means of completely eradicating this terrible scourge, by substituting the same disease in a mild, modified form non-communicable by effluvia and capable of affording complete immunity from the natural small-pox.

So far, therefore, from charging the accidents which we are about to describe, to the process of vaccination, as established and advocated by Edward Jenner, we are persuaded that a very large part, if not the whole of these distressing accidents and failures, are to be ascribed directly or indirectly to the ignorance, and inattention, of those who practice vaccination. We have no more sympathy with the modern opponents of vaccination, than we have with those English physicians who attempted to decry the labors and to steal the honest dues of their immortal countryman, and who condescended to such low expedients as to caricature the process of vaccination, by representing the human visage under its effects, in the act of transformation into that of the lower animals, the cow and the horse. And we would heartily endorse any public enactment which would guard in a proper manner the process of vaccination; and at the present time some of the older European edicts upon the subject of vaccination, as those of the Emperor of Russia in 1811, and of the King of Wirtemburgh in 1818, might be reenacted by the General and State Governments, with great benefit to the people.

If the profession had uniformly adhered to the advice and the rules established by the illustrious founder of vaccination, we would have been spared the vast majority of the unfortunate accidents which tend to bring this, the only safeguard against the small-pox, into disrepute.

Dr. Jenner gave the most minute attention to every deviation from the correct progress of the vaccine vesicle, to the state of the virus to be inserted, to the condition of the skin of the person about to be vaccinated, and to the character of the vesicle

itself; and so early as the year 1799, had ascertained by the clearest evidence, some of the causes of accident and failure, which have been confirmed by later observations.

He showed that in some cases the system was not rendered totally unsusceptible to the variolous contagion, either by the cow-pox vaccination, or the small-pox; but that vaccination, when properly performed with genuine matter, afforded as complete protection as the small-pox itself. He proved that by inoculating a person who had gone through the cow-pox, with variolous matter, it was possible to excite a local vesication, the virus from which was capable of producing a mild but efficacious small-pox. He farther maintained that modifications and varieties might arise in the vaccine pustule, and that these varieties were such as to produce "every gradation in the state of the pustule, from that slight deviation from perfection, which is quite immaterial, up to that point which affords no security at all." He held that fluid taken from a spurious vaccine pustule can propagate and perpetuate its like, and even if it be taken from a genuine pustule in its far-advanced stages, it is capable of producing varieties which will be permanent if we continue to employ it.

Jenner laid great stress upon the herpetic state of the skin, in inducing deviation in the normal progress of the vaccine disease; but every deviation, from whatever cause it may have arisen, was considered by him of the greatest moment; and in all his published works, as well as in his private communications and letters, he never failed to urge the importance of the most scrupulous attention to the mode of propagation and to the whole progress of the vaccine disease.

Thus in his paper on the "Varieties and Modifications of the Vaccine Pustule," he thus urges upon the profession the necessity of the most careful attention to this important subject:

"I shall conclude this paper by observing that although vaccine inoculation does not inflict a severe disease, but, on the contrary, produces a mild affection, scarcely meriting the term *disease*, yet, nevertheless, the inoculator should be extremely careful to obtain a just and clear conception of this important branch of medical science. He should not only be acquainted with the laws and agencies of the vaccine virus on the constitution, but with those of the variolous also, as they often interfere with each other.

"A general knowledge of the subject is not sufficient to enable us to warrant a person to practice vaccine inoculation: he should possess a peculiar knowledge; and that which I would wish strongly to inculcate, as the great foundation of the whole, is an intimate acquaintance with the character of the true and genuine pustule. The spurious pustule would then be readily detected, whatever form it might assume; and errors known no more."

Dr. Jenner, in a letter written to Sir Gilbert, near the close of his life, reiterates these precautions, and observes:

"With regard to the mitigated disease which sometimes follows vaccination, I can positively say, and shall be borne out in my assertion by those who are in future days to follow me, that it is the offspring entirely of incaution in those who conduct the vaccine process. On what does the inexplicable change which guards the constitution from the fang of the small-pox depend? On nothing but a correct state of the pustule on the arm excited by the insertion of the virus; and why are these pustules sometimes incorrect, losing their characteristic shape, and performing their offices partially?"—(*Life of Edward Jenner, M.D., L.L.D., etc., by John Barrow, M.D., Vol. ii., p. 241.*)

Jenner even went so far as to maintain that the process of vaccination might be rendered ineffective by mechanically disturbing the vesicle, during the collection and transmission of the virus, and he insisted upon the necessity of allowing one vesicle at least to run its course undisturbed.

So far, therefore, from desiring to injure the cause of vaccination by the record of distressing failures and accidents, it will be our endeavor, rather in the spirit of Jenner, to guard the process, by so exposing the cause of these accidents as to lead to their avoidance in future.

"Ere I proceed, let me be permitted to observe, that truth in this, and every other physiological inquiry that has occupied my attention, has ever been the first object of my pursuit; and should it appear in the present instance that I have been led into error, fond as I may appear of the offspring of my labors, I had rather see it perish at once than exist and do a public injury."

SECTION II.

MODIFICATION, ALTERATION AND DEGENERATION OF THE VACCINE VESICLE, DEPENDENT UPON DEPRESSED AND DERANGED

FORCES, RESULTING FROM FATIGUE, EXPOSURE AND POOR DIET; AND UPON AN IMPOVERISHED, VITIATED AND SCORBUTIC CONDITION OF THE BLOOD OF THE PATIENTS VACCINATED AND YIELDING VACCINE MATTER. IN SCORBUTIC PATIENTS ALL INJURIES OF THE SKIN TEND TO FORM ULCERS OF AN UNHEALTHY CHARACTER. EFFECTS OF SCURVY UPON THE CHARACTER AND PROGRESS OF THE VACCINE VESICLE. INVESTIGATIONS UPON THE EFFECTS OF VACCINATION AMONGST THE FEDERAL PRISONERS CONFINED IN CAMP SUMPTER, ANDERSONVILLE, GA. LETTER AND REPORT ON SPURIOUS VACCINATION, BY DR. S. E. HABERSHAM.

Large numbers of the Confederate soldiers manifested slight scorbutic symptoms, which were not sufficient to attract attention, or to induce treatment, and as far as we could learn, no attention was paid to this condition either in vaccination or in the selection of the vaccine lymph.

In scorbutic patients, all injuries tended to form ulcers of an unhealthy character, and the vaccine vesicles even when they appeared at the proper time, and manifested many of the usual symptoms of the vaccine disease, were nevertheless larger and more slow in healing, and the scabs presented an enlarged, scaly, dark, unhealthy appearance. In many cases, a large ulcer covered with a thick laminated crust, from one-quarter to one inch in diameter, followed the introduction of the vaccine matter into scorbutic patients. Matter from these scabs and sores was frequently used in vaccination, and this decomposing pus and blood acted as an animal poison in some cases, and especially in constitutions debilitated by exposure, fatigue, and salt diet.

During the prosecution of the investigations which we instituted upon the diseases of the Federal prisoners confined at Andersonville, the opportunity was embraced of investigating the remarkable effects which followed the attempts of the Confederate medical officers to arrest the spread of small-pox by vaccination. In a number of cases, large gangrenous ulcers appeared at the points where the vaccine lymph had been inserted, causing extensive destruction of tissues, exposing arteries, nerves, and

bones, and necessitating amputation in more than one instance. These accidents led to the belief amongst some of the prisoners that the Surgeons had intentionally introduced poisonous matter into their arms during vaccination.

After careful inquiry we were led to the conclusion that these accidents were, in the case of these Federal prisoners, referable wholly to the scorbutic condition of their blood, and to the crowded condition of the stockade and hospital. The smallest accidental injuries and abrasions of the surface, as from splinters, or bites of insects, were in a number of instances followed by such extensive gangrene as to necessitate amputation. The gangrene following vaccination appeared to be due essentially to the same cause; and in the condition of the blood of these patients, would most probably have attacked any puncture made by a lancet, without any vaccine matter or any other extraneous material. It appeared also that the dried scab, resulting from the vaccination of these scorbutic patients, was also capable of producing effects wholly different from the vaccine lymph of healthy individuals; and in some cases these effects were of a most potent and injurious character.

The cause of JUSTICE and TRUTH, demands at my hands, something more, than this simple record, with reference to the accidents following vaccination, amongst the Federal prisoners confined in Camp Sumpter.

In the specification of the first charge against Henry Wirz, formerly Commandant of the interior of the Confederate States Military Prison, during his *Trial* before a *Special Military Commission*, convened in accordance with Special Orders No. 453, War Department, Adjutant General's Office, Washington, August 23, 1865, the following is written:

"And the said Wirz, still pursuing his wicked purpose, and still aiding in carrying out said conspiracy, did use and cause to be used, for the pretended purpose of vaccination, impure and poisonous matter, which said impure and poisonous matter was then and there, by the direction and order of said Wirz, maliciously, cruelly, and wickedly deposited in the arms of many of said prisoners, by reason of which large numbers of them, to-wit, one hundred, lost the use of their arms, and many of them, to-wit, about the number of two hundred, were so injured that they soon thereafter died: All of which he, the said Henry Wirz, well knew and maliciously

intended, and in aid of the then existing rebellion against the United States, with the view to assist in weakening and impairing the armies of the United States, and in furtherance of the said conspiracy, and with full knowledge, consent and connivance of his co-conspirators aforesaid, he the said Wirz, then and there did."

Amongst the co-conspirators specified in the charges, were the Surgeon of the Post, Dr. White, and the Surgeon in charge of the Military Prison Hospital, R. R. Stevenson. As the vaccinations were made by their orders, and by the medical officers of the Confederate Army acting under their command, the charge of deliberately poisoning the Federal Prisoners with vaccine matter, is a sweeping one, and whether intended so or not, affects every medical officer stationed at that post; and it appears to have been designed to go farther and to affect the reputation of every one who held a commission in the Medical Department of the Confederate Army.

The acts of those who once composed the Medical Department of the Confederate Army, from the efficient and laborious Surgeon General to the Regimental officers, need no defence at my hands: time, with its unerring lines of historic truth, will embalm their heroic labors in the cause of suffering humanity, and will acknowledge their untiring efforts to ameliorate the most gigantic mass of suffering, that ever fell to the lot of a beleaguered and distressed people.

I desire at the present time, simply to place on record, the results of labors which concern this country, no more than any other; and these results when properly received without prejudice or malicious hatred, will be seen to relate to the hygiene and to the diseases of Prisoners, however confined, and wherever incarcerated, in civil or military prisons throughout the world.

In accordance with the direction of Dr. Samuel Preston Moore, formerly Surgeon General C. S. A., I instituted during the months of August and September, 1864, a series of investigations upon the diseases of Federal Prisoners confined in Camp Sumpter, Andersonville, Georgia.

The field was of great extent and of extraordinary importance. There were more than five thousand seriously sick in the hospital and stockade, and the deaths ranged from ninety, to one hundred

and thirty, each day. From the establishment of the Prison, on the 24th of February, 1864, to the 1st of October, over ten thousand Federal prisoners died; that is, near one-third of the entire number perished in less than seven months. I instituted careful investigations into the condition of the sick and well, and performed numerous post-mortem examinations, and executed drawings of the diseased structures. The medical topography of Andersonville and of the surrounding country was examined, and the waters of the streams, springs and wells, around and within the stockade and hospital carefully analyzed.

The report which I drew up for the use of the Medical Department of the Confederate Army, contained a truthful representation of the sufferings of these prisoners, and at the same time gave an equally truthful view of the difficulties, under which the medical officers labored, and of the distressed, and beleaguered and desolated condition of the Southern States. Shortly after the close of the civil war, this report, which had never been delivered, on account of the destruction of all railroad communication with Richmond, Virginia, was suddenly seized by the agents of the United States government, conducting the trial to which we have alluded.

It was with extreme pain that I contemplated the diversion of my labors, in the cause of Medical science, from their true and legitimate object, and I addressed an earnest appeal, which accompanied the report, to the Judge Advocate, Col. N. P. Chipman, in which I used the following language:

In justice to myself, as well as to those most nearly connected with this investigation, I would respectfully call the attention of Col. Chipman, Judge Advocate U. S. A., to the fact that the matter which is surrendered in obedience to the demands of a power from which there is no appeal, was prepared solely for the consideration of the Surgeon General, C. S. A., and was designed to promote the cause of humanity, and to advance the interests of the Medical profession. This being granted, I feel assured that the Judge Advocate will appreciate the deep pain which the anticipation gives me that these labors may be diverted from their original mission, and applied to the prosecution of criminal cases. The same principle which led me to endeavor to deal humanely and justly by these suffering prisoners, and to make a truthful representation of their condition to the Medical Department of the Confederate Army, now actuates me in recording my belief that as far as my knowledge extends, there was no deliberate or willful design on the part of the Chief

Executive, Jefferson Davis, and the highest authorities of the Confederate Government to injure the health and destroy the lives of these Federal Prisoners.

On the 21st of May, 1861, it was enacted by the "Congress of the Confederate States of America," "That all prisoners of war taken, whether on land or at sea, during the pending hostilities with the United States, should be transferred by the captors, from time to time, as often as convenient, to the Department of War; and it shall be the duty of the Secretary of War, with the approval of the President, to issue such instructions to the Quartermaster General and his subordinates, as shall provide for the safe custody and sustenance of prisoners of war; and the rations furnished prisoners of war shall be the same in quantity and quality as those furnished enlisted men in the army of the Confederacy." By act of February 17, 1864, the Quartermaster General was relieved of this duty, and the Commissary General of Subsistence was ordered to provide for the sustenance of prisoners of war.

According to General Orders No. 159, Adjutant and Inspector General's Office, "hospitals for prisoners of war are placed on the same footing as other Confederate States hospitals, in all respects, and will be managed accordingly."

The Federal prisoners were removed to South-western Georgia in the early part of 1864, not only to secure a place of confinement more remote than Richmond and other large towns, from the operations of the United States forces, but also to secure a more abundant and easy supply of food.

As far as my experience extends, no person who had been reared upon wheat bread, and who was held in captivity for any length of time, could retain his health and escape either scurvy or diarrhoea, if confined to the Confederate ration (issued to the soldier in the field and hospital) of unbolied corn meal and bacon. The large armies of the Confederacy suffered more than once from scurvy, and as the war progressed, secondary hemorrhage and hospital gangrene became fearfully prevalent, from the deteriorated condition of the systems of the troops, dependent upon the prolonged use of salt meat. And but for the extra supplies received from home and from the various benevolent State institutions, scurvy and diarrhoea and dysentery would have been still further prevalent."

It was believed by the citizens of the Southern States, that the Confederate authorities desired to effect a continuous, and speedy exchange of prisoners of war in their hands, on the ground that the retention of these soldiers in captivity was a great calamity, not only entailing heavy expenditure of the scanty means of subsistence, already insufficient to support their suffering, half-starved, half-clothed and unpaid armies, struggling in the field with overwhelming numbers, and embarrassing their imperfect and dilapidated lines of communication; but also as depriving them of the services of a veteran army fully equal to one-third the numbers actively engaged in the field; and the history of subsequent events have shown that the retention in captivity of the Confederate prisoners was one of the efficient causes of the final and complete overthrow of the Confederate Government. * * *

It is my honest belief that if the exhausted condition of the Confederate Government, with its bankrupt currency, with its retreating and constantly diminishing armies, with the apparent impossibility of filling up the vacancies by death and desertion and sickness, and of gathering a guard of reserves of sufficient strength to allow of the proper enlargement of the Military Prison, and with a country torn and

bleeding along all its borders with its starving women and children and old men fleeing from the desolating march of contending armies, crowding the dilapidated and over-burdened railroad lines, and adding to the distress and consuming the poor charities of those in the interior, who were harrassed by the loss of sons and brothers and husbands, and by the fearful visions of starvation and undelivered misery, could be fully realized, much of the suffering of the Federal prisoners would be attributed to causes connected with the distressed condition of the Southern States.

It was clearly demonstrated in my report that diarrhoea, dysentery, scurvy and hospital gangrene were the diseases which caused the extraordinary mortality of Andersonville. And it was still farther shown that this mortality was referable, in no appreciable degree, to either the character of the soil, or waters, or the conditions of climate.

The effects of salt meat and farinaceous food, without fresh vegetables, were manifest in the great prevalence of scurvy. The scorbutic condition thus induced, modified the course of every disease, poisoned every wound, however slight, and lay at the foundation of those obstinate and exhausting diarrhoeas and dysenteries, which swept off thousands of these unfortunate men. By a long and painful investigation of the diseases of these prisoners, supported by numerous post-mortem examinations, I demonstrated conclusively that scurvy induced nine-tenths of the deaths. Not only were the deaths registered as due to unknown causes, to apoplexy, to anasarca, and to debility, directly traceable to scurvy and its effects, and not only was the mortality in small-pox and pneumonia and typhoid fever, and in all acute diseases more than doubled by the scorbutic taint, but even those all but universal and deadly bowel affections, arose from the same cause, and derived their fatal characters from the same conditions which produced the scurvy.

Scurvy and hospital gangrene frequently existed in the same individual. In such cases, vegetable diet, with vegetable acids, would remove the scorbutic condition without curing the hospital gangrene. It has been well established by the observations of Blane, Trotter and others, that the scorbutic condition of the system, especially in crowded camps, ships, hospitals and beleaguered cities, is most favorable to the origin and spread of foul ulcers and hospital gangrene. In many cases occurring amongst

the Federal prisoners at Andersonville, it was difficult to decide at first whether the ulcer was a simple result of the scorbutic state, or of the action of the poison of hospital gangrene; for there was great similarity in the appearance of scorbutic ulcers and genuine hospital gangrene. So commonly have these two diseases been combined, that the description of scorbutic ulcers by many authorities, evidently, includes also many of the prominent characteristics of hospital gangrene, as will be seen by a reference to the descriptions of Lind, Trotter, Blane, and others.

More than two hundred and fifty years ago, Paré described a condition of things similar to that of Andersonville: at the siege of Rouen, the air was so noxious that no wounds would heal, and the besieged finding that all their wounds became gangrenous, reported that the besiegers had poisoned the walls; the besiegers also seeing none but putrid sores in the camp, believed that the wounds were poisoned, and both within and without the city such was the state of the air, and so putrid were all the wounds, that the surgeons could scarcely look upon the sores, or endure the smell; and if they neglected them for a single day, they found them filled with worms.

Woodall, in his *Chirurgeon's Mate, or Military and Domestic Surgery*, published in 1639, not only carefully describes scorbutic ulcers, but also lays down rules for their treatment; and Gideon Harvey, twenty-four years later, in his "*Venus Unmasked*," mentions superficial, profound, simple, inflamed, callous, dry, sanious, purulent, phagedenic, and gangrenous ulcers, as characteristic of scurvy. This last named author derives the name scurvy from "Scorbeck, and that from Scornobocca, or Fowl mouth, (from Scorno a Fowl or shameful thing, and bocca the mouth), for a stinking breath and fowl rotten gums, may still be termed a foul or shameful mouth; they call it also *La marcia di bocca*, or putrefaction of the mouth."—p. 24.

The British seamen, in Lord Anson's voyage, and in fact in all long voyages, before the mode of preventing scurvy was practiced, suffered terribly from scorbutic ulcers.

John Huxham in his *Essay on Fevers*, in the chapter in which he discourses on the "disordered and putrid state of the blood," observes that the

"Salt and half-rotten provisions of sailors in long voyages, cause such a sharpness and corruption of the humors that they are rendered almost unfit for the common uses of life, producing great weakness, languor, wandering pains and aches, stinking breath, corroded, spongy gums, black, blue and yellow spots, sordid, dark, livid fungous ulcers, gangrene, etc., etc. Such scorbutics frequently fall into pateschial fevers, bloody dysenteries, hemorrhages, etc. What is mentioned by the Rev. Mr. Walter in Lord Anson's voyage, is very surprising, viz.: that the blood burst from the wounds of some of the scorbutics after they had been cicatrized for twenty or thirty years. I have known many a ship's company set out on a cruise in high health, and yet in two or three months, return vastly sickly, and eaten out with the scurvy, a third part of them half-rotten and utterly unfit for service. About four or five weeks after they have been out, they begin to drop down, one after another and at length by dozens, till at least scarce half the complement can stand to their duty, particularly I remember some years since, from a squadron under Admiral Martin, we had near 1200 men put on the shore sick at one time, though they went out very healthy and returned in about twelve or thirteen weeks."—p. 47.

Dr. John Hunter, Surgeon in the English Army, in his "Observations on the Diseases of the Army in Jamaica," states that

"Sores and ulcers in the lower extremities were frequent at all seasons of the year and in all the different quarters where the soldiers were stationed. They together with fevers and fluxes, amounted to nineteen-twentieths of the sick received into the hospitals, all other complaints not being more than one-twentieth, if particular times be excepted, when the dry-belly-ache or small-pox were prevalent. The proportion of sores in the hospitals, though always considerable, admitted of great variation. At Spanish Town and Kingston they were often one-third; at Fort Augusta, one-half, and at Stony Hill, two-thirds of the whole number in hospital. They arise from the most trifling causes; a scratch, or hurt, or bruise in the lower extremities, are sufficient to produce a sore, which is always difficult to heal, and sometimes impossible. Old sores often break out anew, and prove equally obstinate."

Dr. Lind, in his valuable work on the scurvy, has recorded the fact that the slightest bruises and wounds of scorbutic persons may degenerate into offensive bloody and fungous ulcers, which are prone to spread with great rapidity, which are cured with the greatest difficulty. The distinguishing characteristics of scorbutic ulcers, as given by Dr. Lind, are as follows:

"They do not afford a good digestion, but a thin fetid matter, mixed with blood, which at length has the appearance of coagulated blood, and is with great difficulty wiped off or separated from the parts below. The flesh underneath these sloughs feels to the probe soft and spongy. No irritating applications are here of any service: for though such sloughs be with great pains taken away, they are found again

at next dressing, when the same bloody appearance always presents itself. Their edges are generally of a livid color and puffed up with excrescences of luxuriant flesh arising under the skin. When too tight a compression is made, in order to keep the excrescences from arising, they are apt to have a gangrenous disposition; and the member never fails to become swelled, painful and for the most part spotted. As the disease increases, they come at length to shoot out a soft bloody fungus, which the sailors express by the name of bullock's liver: and indeed it has a near resemblance, in consistence and color, to that substance when boiled. It often rises in a night's time to a monstrous size, and although destroyed by caustics, or the knife, (in which last case a plentiful bleeding generally ensues), is found at next dressing as large as ever. They continue, however, in this condition a considerable time without tainting the bone. The slightest bruises and wounds of scorbutic persons degenerate sometimes into such ulcers. Their appearances on whatever part of the body, is singular and uniform; and they are easily distinguished from all others, by being so remarkably offensive, bloody and fungous, that we cannot here but take notice of the impropriety of referring many inveterate and obstinate ulcers on the legs, with very different appearances, to scurvy; which are generally best cured by giving mercurial medicines: whereas that medicine in a truly scorbutic ulcer is the most dangerous and pernicious that can be administered."

In like manner Doctor David Macbride in his "Methodical Introduction to the Theory and Practice of Physic," London, 1772, p. 618, affirms that:

"The slightest wounds and bruises in scorbutic people degenerate into foul and untoward ulcers. And the appearance of these ulcers is so singular and uniform that they are easily distinguished from all others. Scorbutic ulcers afford no good digestion, but a thin and fetid ichor mixed with blood, which at length has the appearance of coagulated gore lying caked on the surface of the sore, and is with great difficulty wiped off or separated from the parts below. The flesh underneath these sloughs feels to the probe soft and spongy, and is very putrid. No detergents nor escharotics are here of any service; for though such sloughs be with great pains taken away, they are found again at the next dressing, where the same sanguinous putrid appearance always presents itself. Their edges are generally of a livid color, and puffed up with excrescences of putrid flesh arising from below the skin. As the violence of the disease increases, the ulcers shoot out a soft bloody fungus, which often rises in a night's time to a monstrous size, and although destroyed by caustics, actual or partial, or cut away with the knife, is found at next dressing as large as ever. It is a good while, however, before these ulcers, bad as they are, come to affect the bone with rottenness."

Sir Gilbert Blane, in his "Observations on the Diseases of Seamen," affirms that there is no complaint more hurtful to the public service, by sea and land, and none more afflicting to the individual than ulcers.

"It is found," says Dr. Blane in the work just referred to, "from direful and multiplied experience, that not only those who are afflicted with actual symptoms of scurvy, but those who are exposed to the causes of it, and whose constitutions are in such a train as to fall into it, are particularly susceptible of ulcers of the most malignant kind, from the smallest injury which breaks the skin. This might naturally be expected, from what has been said of the great debility of the fibres, and deficiency of the powers of renovation and nutrition in this disease. The characteristic symptoms of such ulcers, are, a thin, fetid discharge, commonly mixed with blood, which sometimes coagulates on the surface. The ulcerated surface is soft and spongy, generally elevated above the level of the surrounding skin, particularly about the edges, where there are excrescences of luxuriant flesh, which in the more advanced state of the ulcer, shoots into a soft bloody fungus, called by the sailors bullock's liver."—*Third Ed., London, 1799—p. 502.*

Dr. Blane records a number of important observations showing the tendency to foul gangrenous ulcers amongst seamen. On board the *Ganges*, of seventy-four guns and six hundred men, during the year 1798, the tendency to the complaint was such that the smallest sore, whether from a hurt or a pimple, fell into the state of an ulcer. Blistered parts were also affected in the same manner. Sores which seemed to be in a healing state, would suddenly become gangrenous. A black speck in the middle was the constant precursor of this. In the most severe cases the ulcers began with violent inflammation, which suddenly terminated in mortification; destroying in a short time, the fleshy parts, so as to expose the bone, which soon became carious.

The crew of the *Triumph*, of seventy-four guns and six hundred men, suffered severely from malignant ulcers during the summer and autumn of 1798. Not only wounds and blisters fell into the ulcerated state, but a scratch or boils and the orifice of the arm after bleeding, were subject to the same accident. Sores which seemed to be in a healing state, would suddenly and without any visible cause, spread again, and become foul and bloody, extremely painful, and would resist every means of cure.

This unfavorable change always began, as in the *Ganges*, with a black spot in the middle of the ulcer. Ulcers of the same kind prevailed to the most dreadful degree, in the ships serving at the Cape of Good Hope, and in the Naval Hospital there, in the years 1796 and 1797. These foul ulcers produced the most severe and protracted sufferings, terminating frequently in the

loss of limbs or life, or both. Nor were they confined to the lower extremities, for the *ossa ilium*, the *scapula* and *cranium* would sometimes become *carious*. It became frequently necessary to amputate at the hospital, and it was observed that if the patients who underwent the operation, remained in the wards, with the ulcers, few survived, owing to the gangrenous and ulcerous states of the stumps; but when they were carried into a separate apartment, the large majority recovered.

It was also observed, both in the ships and at the hospitals, where this species of ulcer prevailed, that the hands of those who dressed them, where the skin was broken, were attacked by the same sort of ulcer.—*Observations on the Diseases of Seamen*, by Gilbert Blane, M.D.—pp. 506-512.

Doctor Thomas Trotter, in his *Medicina Nautica*, has in like manner, recorded a large number of instances where malignant gangrenous ulcers have arisen spontaneously in various ships, and attacked with violence, not only external injuries; but in a number of cases, where neither wound, puncture, scab, or contusion could be said to have first taken place, a circumscribed red spot would be first perceived, scarcely to be felt, but in a few hours rising to a pimple, becoming black in the centre and inflamed around the edges, till it increased in size, swelled and assumed every characteristic symptom of malignant ulcer, with constant fever and subsequent ulceration, slough and fetid discharge. This malignant or gangrenous ulcer attacked also the flesh wounds made with the lancet in bleeding, for different inflammatory diseases, as catarrhs and sore-throats. Contused spots, even where the cuticle was not broken, were not exempted from the general tendency to ulceration. But parts that had been scalded or burnt, above all accidents, most quickly assumed the nature of this horrid sore, spread and inflamed more rapidly, and in the end put on the most formidable appearance; deeper and larger sloughs were the consequence, and symptomatic fever violent in proportion. Even in the early stage, sometimes before the cuticle had burst so as to expose the naked surface, buboes appeared in the groin and axilla, not to be touched without much pain, and always attended with fever. These, however, seldom suppurated;

but where they did, they constantly exhibited the complexion of the parent sore. (*Medicina Nautica*, an Essay on the Diseases of Seamen, by Thomas Trotter, M.D., &c., Sec. Ed., 1804, vol. 2d, pp. 169-230; vol. 3d, pp. 467-504).

Dr. Trotter, in the 3d volume states that in the summer of 1799 the malignant ulcer made its appearance on board the *Temeraire*, with all the characteristic symptoms and violence which marked it in other ships. Every wound, abrasion of the cuticle, blistered part, scald or burn, passed rapidly through the various stages of inflammation, gangrene and sphacelus; in a few days leaving the bones almost bare, from the separation of immense sloughs.

The tendency of the bones to *caries* after inflammation in this disease, was more frequent than in any other species of ulcer, and in many cases rendered the cure very tedious and painful; and many cases sank under the long confinement necessary to the separation of the dead bones.

Dr. George H. B. Macleod, in his "Notes on the Surgery of the War in the Crimea," states that

"The French suffered most dreadfully from hospital gangrene in its worst form. The system they pursued, of removing their wounded and operated cases from the camp to Constantinople at an early date, the pernicious character of the transit, the crowding of their ships and hospitals, all tended to produce the disease, and to render it fatal when produced. Many of their cases commenced in camp, but the majority arose in the hospitals on the Bosphorus, where the disease raged rampant. In the hospitals of the south of France it also prevailed, and, from what M. Lalour, Surgeon to the "Euphrate" transport, tells us in his paper on the subject, it must have committed great ravages in their ships, from one of which, he says, sixty bodies were thrown over during the short passage of thirty-eight hours to the Bosphorus. With them the disease was the true contagious gangrene, and attacked not only open wounds but écorchures, and almost every stump in the hospitals."

By the official reports of the medical officers of both the English and French Armies, during the Crimean war, it was conclusively shown that, notwithstanding the extraordinary exertions of these powerful nations, holding undisputed sway of both sea and land, scurvy and a scorbutic condition of the blood, increased to a fearful degree the mortality, not only of gun-shot wounds, but of all diseases, and especially of pneumonia, diarrhoea and dysentery.

We might add many other facts from various authors establishing the spontaneous origin of malignant spreading gangrenous ulcers, in many navies and armies, as the result of scurvy and crowding; but the facts just recorded are sufficient to show that the foul scorbutic ulcers, and hospital gangrene, and the accidents from vaccination, arising at Andersonville, were by no means new, in the history of medicine, and that the causes which induced these distressing affections have been active in all wars and sieges, and amongst all armies and navies.

In truth these men at Andersonville, were in the condition of a crew at sea, confined upon a foul ship, upon salt meat and unvarying food, and without fresh vegetables. Not only so, but these unfortunate prisoners were like men forcibly confined and crowded upon a ship, tossed about on a stormy ocean, without a rudder, without a compass, without a guiding star, and without any apparent boundary or end to their voyage; and they reflected in their steadily increasing miseries, the distressed condition and waning fortunes of a devastated and bleeding country, which was compelled, in justice to her own unfortunate sons, to hold these men in this most distressing captivity.

The Federal prisoners received the same rations in kind, quality, and amount, issued to the Confederate soldiers in the field. These rations were, during the last eighteen months of the war, insufficient, and without that variety of fresh meat and vegetables, which would ward off scurvy from soldiers, as well as prisoners.

As far as my experience extended, no body of troops could be confined exclusively to the Confederate rations of 1864 and '65 without manifesting symptoms of the scurvy.

The Confederate ration grew worse and worse as the war progressed, and as portion after portion of the most fertile regions of the Confederate States were overrun and desolated by the Federal Armies. In the straightened condition of the Confederate States, the support of an army of fifty thousand prisoners, forced upon their hands by a relentless policy, was a great and distressing burden, which consumed their scant resources, burdened their rotten lines of railroad, and exhausted the over-taxed

energies of the entire country, crowded with refugees from their desolated homes. The Confederate authorities charged with the *exchange of prisoners*, used every effort in their power consistent with their views of national honor and rectitude, to effect an exchange of all prisoners in their hands, and to establish and maintain definite rules by which all prisoners of war might be continuously exchanged as soon as possible after capture.

Whatever the feelings of resentment on the part of the Confederates, may have been, against those who were invading and desolating their native land, which had been purchased by the blood of their ancestors from the Indians and English, the desire for the speedy exchange and return of the great army of veterans held captives in Northern prisons, was earnest and universal; and this desire for speedy and continuous exchange on the part of the government, as well as on the part of the people, sprang not merely from motives of compassion for their unfortunate kindred and fellow-soldiers, but also from the dictates of that policy, which would exchange on the part of a weak and struggling people, a large army of prisoners (consumers and non-combatants, requiring an army for their safe-keeping), for an army of tried veterans.

Apart from the real facts of the case, it is impossible to conceive that any government, in the distressed and struggling state of the Confederate States, could deliberately advocate any policy which would deprive it of a large army of veterans, and compel it to waste its scant supplies, already insufficient for the support of its struggling and retreating armies.

And the result has shown that the destruction of the Confederate Government was accomplished as much by the persistent retention in captivity of the Confederate soldiers, as by the emancipation and arming of the Southern slaves, and the employment of European recruits.

And still farther to show that these accidents attending vaccination at Andersonville were active in Northern prisons, we quote the testimony of a medical officer who occupied during the war a distinguished position in the Medical Department of the United States Army.

Dr. Frank Hastings Hamilton, late Lieutenant-Colonel, Medical Inspector, U. S. A., in his "Treatise on Military Surgery," records the following facts which have an important bearing upon the subject under consideration:

"In still further confirmation of the correctness of our views, we will mention that in many of the regiments stationed in Kentucky and Tennessee during the summer of 1863, all slight wounds, such as scratches, slight burns, etc., took on an ulcerative action and often became ugly and intractable sores. Vaccination almost constantly produced the same results, and was in many cases followed by abscesses in the axillary, cervical, and other glands."

"Upon the evacuation of Murfreesboro by the Confederate Army, on the first of January, 1863, 1673 sick and wounded soldiers were left in our hands; of these 256 were sick, and 1423 were wounded. The whole number were placed in charge of Dr. Avent, the intelligent Medical Director of General Bragg's army, assisted by several other Confederate Surgeons, and were allowed to remain in the buildings which they had originally taken as hospitals, and which were the best the place afforded. On the 20th of May, 1863, nearly five months after the battle of Stone's River (Murfreesboro), Dr. Avent reported to us that 640 of these men had died, and 55 remained in the hospital, the remainder having been sent off for exchange. The ratio of deaths, continues Dr. Avent, allowing the same percentage for the 65 now on hand, is about 381 per cent. I have not separated the sick in this calculation from the wounded, from the fact that the hospitals were common to both; consequently I have no positive data on which to make an estimate of the relative mortality. I am satisfied, however, that the mortality amongst the sick has been much less than of the wounded. An estimate, placing the percentage of the wounded at about 40, I think would not be far wrong; which loss, you will discover, is unprecedented in any previous battle between the present belligerents."

"In explanation of this great mortality after wounds, Dr. Avent proceeds to offer several facts; namely, over-crowding of the patients in the hospital buildings, mental depression, the fact that only the most severely wounded were left behind; but he gives especial prominence to the physical condition of the men, in consequence of a prolonged absence in their food of anti-scorbutic articles, both before and since their capture."

We have here a far heavier mortality amongst these Confederate Prisoners, than amongst the Andersonville Prisoners; and according to the published statements of the United States Government the majority of deaths during the war was largely on the side of the Confederate Soldiers confined in Northern Prisons. And after careful inquiries amongst returned Confederate prisoners, I am convinced that the accidents attending vaccination were quite as numerous and severe in Northern Prisons as in Southern; and the causes of death amongst prisoners in both

sections were not materially different, with this exception, that the heat of the Southern States was balanced by the effects of severe cold upon feeble scorbutic men with insufficient clothing.

We have dwelt thus long upon this subject, because we have considered its discussion, of paramount interest, in the history of vaccination, and of the Profession in America.

In many cases occurring in the Confederate Army, the deleterious effects of vaccination, were clearly referable to the condition of the forces, and the constitution of the blood of the patients, for it was observed in a number of instances that the same lymph from a healthy infant, inoculated upon different individuals, produced results corresponding to the state of the system; in those who were well fed and robust, producing no ill effects, whilst in the soldiers who had been subjected to incessant fatigue, exposure and poor diet, the gravest results followed.

The history of vaccination in the Army of Virginia under General Lee was of great interest, in the light which it threw upon these questions, and it is with deep regret that we learn that all the most valuable field reports were destroyed.

The following letter from Dr. L. Guild, formerly Medical Director of the Army of Northern Virginia (General Lee's Army), was received in reply to my request, for the experience upon this subject, of this surgeon, who had held one of the most responsible and distinguished positions in the Medical Department of the Confederate Army.

MOBILE, ALA., 12th Dec., 1866.

PROFESSOR JOSEPH JONES—Dear Sir:—Your letter of the 5th inst., has been received.

It would afford me great pleasure to contribute to your contemplated monograph on "Spurious Vaccination;" but in the retreat of the Army of Northern Virginia from Petersburg to Appomattox Court-House, all of the retained papers, professional notes, reports, &c., of my office were either destroyed by the enemy or burned, with other baggage, by our own people for the purpose of lightening our trains and facilitating the movement of our retreating columns. When the boxes were burned their contents were, of course, unknown to those entrusted with the execution of the order. On account of this misfortune, I have nothing with which to refresh my memory accurately, in a single case, out of the vast number that came under my observation.

The subject of the transmission of syphilis through the vaccine virus is a most

interesting and important one to the profession—admitting great diversity of opinion, and, as you truthfully remark, "one well-reported case is worth volumes of mere opinions and assertions."

I know of no one who could report such a case, but much useful information on the subject can be furnished by Dr. R. J. Breckinridge—now of Houston, Texas—formerly of Louisville, Ky. He was one of the Medical Inspectors of the Army of Northern Virginia, and it was his duty, on several occasions, to collect and collate all interesting facts and opinions on the subject, such as the nature and character of the lesions following vaccination, anterior history of patients, effects of treatment constitutional and local, &c., &c.

I regret my inability to furnish something worthy of your consideration.

Respectfully, yours, &c.,

L. GUILD.

The testimony of Dr. S. E. Habersham, upon this cause of the abnormal phenomena accompanying and following vaccination, is clear and important.

The following Report, was placed in my hands by its author, and was accompanied with the following answer to my request and inquiries:

SEMMERVILLE, April 28th, 1866.

DR. JOSEPH JONES—Dear Sir:—The accompanying report of an anomalous disease or result of vaccination, was written shortly after its first appearance in the Army of Northern Virginia, and after a careful study of the cases especially assigned to the Hospital under my charge for "treatment and report." At the time, there was much discussion among the Medical Staff, both in Field and Hospital, as to the etiology and pathology of the manifestation which by some, and, indeed, most of the observers, was attributed to impure virus, and especially syphilitic inoculation. This latter opinion was ingeniously advocated by Surgeon Breckinridge, and no doubt many cases may have resulted from such an accident. In none of the cases, however, assigned to my Division of Chimborazo Hospital, could I discover a sufficient number of symptoms to lead me to suppose that such might have been the cause, either in its prodromia or development, hence I could not attribute the cause of the eruption to any other than that assigned in the report. This view as to its etiology was subsequently very ably maintained by Surgeon Frank A. Ramsey, in a report referred to me by Surgeon-General Moore, and which was preserved among my papers, but lost at the time of the evacuation of Richmond, together with the history of all the cases, and diagrams intended to illustrate the above report. In consequence of the loss of these papers this report is not as perfect as it should be; but I hope the general description and history of the disease is sufficiently clear and comprehensive to embrace every thing of practical importance concerning this horribly disgusting and filthy accident, or result of vaccination, as seen in our army.

Since the termination of the war, I have had several opportunities of conversing with a few intelligent Surgeons of the Federal Army, and ascertained from them that such a disease had appeared among their soldiers in regions of country where the scorbutic diathesis manifested itself among the troops, and to which the disease

was generally attributed by them, though there were also Surgeons of that army who attributed it to syphilitic inoculation. I find the same view as advanced in the accompanying report held by most of the Surgeons of the Federal Army, as stated in Circular No. 6, Surgeon-General's Office, U. S. Army, November 1, 1865.

If you think my report of sufficient importance to appear upon the pages of your journal, or if it can in any way advance the cause of medical knowledge, you are at perfect liberty to make use of it for that purpose.

With much respect, I remain,

Very truly, your obedient servant,

S. E. HABERSHAM.

Report on Spurious Vaccination in the Confederate Army By S. E. HABERSHAM, M.D., Surgeon in the Provisional Army of the Confederate States.

CHIMBORAZO HOSPITAL, DIV. NO. 2, November, 1865.

To Surgeon W. A. CARRINGTON, Medical Director—

SIR: I have the honor to inform you that, in accordance with your order of the 29th June, 1865, I have received all the patients sent into this Division, with a "peculiar eruptive disease," supposed to be the consequence of vaccination, and herewith forward you the results of my investigation into this anomalous affection.

In compliance with an order issued from the Surgeon-General's Office in the month of November, 1862, general vaccination was practiced upon all soldiers as soon as they were admitted into this Division, and in order to insure the full protective influence of vaccination (not anticipating any evil consequences therefrom), the order was strictly obeyed, and all the patients, even those having recent scars upon them, were re-vaccinated. A few days after the insertion of the virus, and, in many cases, within twenty-four hours, the seat of puncture became very much inflamed, with a deep inflammatory blush around it, which gradually implicated, in the severe cases, nearly the whole of the affected limb. A pustule rapidly formed, instead of a vesicle, which very soon discharged an ichorous fluid. This fluid was, in the course of forty-eight hours, converted into a dark, mahogany-colored, irregularly-shaped scab, prominent, and firmly attached at its base. A dark-red areola of several lines in diameter, measuring from the edge of the scab, was then developed, which, in turn, seemed to exude an ichorous serum. This was soon converted into a scab surrounding in juxtaposition the first, and presenting the appearance of a single scab. This process continued for several days, and there was often formed a scab, one inch or two and a half in diameter. "Pari passu" with the increase of this scab, the erysipelatous blush on the limb diminished, and when the blush had disappeared, this scab ceased to enlarge. As this inflammatory process subsided, the discharge lost its serous character, and seemed to be converted into pus, which exuded from under the scab, loosening its firm attachment at its base, and thus rendering it liable to be removed prematurely by the patient in his sleep, or even by the friction of his clothing. When this occurred, a foul bleeding, irregularly shaped phagedenic ulcer was revealed, with everted edges, and presenting the appearance of a Syphilitic phagedenic ulcer, involving the subcutaneous areola tissue, exposing, in many cases, the muscular tissue below. The process of destruction of parts did not end here, for the ulcer continued to increase, and from the loosened edges an

ichorous discharge continued to pour out from under the skin which seemed to destroy the edges of the ulcer, thus increasing its dimensions. Wherever the ichorous pus from this ulcer touched the sound skin, another pustule of a similar character was formed, in some cases reaching the size of the primary sore. This, however, was seldom the case, but a smaller ulcer generally resulted, which often healed and cicatrized before the first.

The Axillary Glands, when the arm was affected, and the Inguinal Glands, when the leg was the seat of the disease, sometimes became inflamed and discharged pus, presenting the microscopic character of healthy pus. This enlargement of glands, however, did not occur in a sufficient number of cases to make it a natural sequence of the disease. Attending the early stages of the formation of the ulcer, before pus was discharged, there was always more or less pyrexia, with furred tongue and loss of appetite; these symptoms disappearing as soon as ulceration was established. In these highly aggravated cases, successive crops of pustules made their appearance on the affected limb, often developing themselves also upon the lower limbs of the affected side, but seldom crossing the median line, and never developing themselves upon the trunk or head.

The less malignant form of the disease resembled the first in character, but not in degree. For a few days after the insertion of the virus, merely a small inflamed spot was discerned, which seemed to be more the result of the injury done to the skin, by the prick of the lancet, than any inflammatory action resulting from a specific cause. About the fifth or sixth day a minute pustule was discerned upon a scarcely larger inflamed base. This pustule and areola gradually increased, but the diameter of the areola was not as great, and there was no deep inflammatory blush upon the arm, merely a diffused redness of several inches in diameter. The same process, however, took place—an exudation of serum from the areola—which, in turn, became a crust, and which gradually increased in size; but it never reached the diameter of the more malignant type; and when it was detached by the process of ulceration, which occurred at an early period, the revealed ulcer was neither as deep nor as malignant in its appearance. The edges were not everted, and there was no discharge of pus from under the edges of the ulcer; it only presented the appearance of an ordinary ulcer, showing no tendency to increase, and but little to heal. Pyrexia very seldom attended this form, nor was the appetite impaired.

The third and mildest form of the disease made its appearance as a small pimple, in from two to ten days after the introduction of the virus, and which gradually formed a pustule; a dark brown scab succeeded in from three to four days, which remained attached sometimes as long as two weeks, and when it became detached, a livid or brown spot was revealed, the size of which was equal to the scab. This scar, however, was very sensitive to the touch, and liable to bleed from the least friction of clothing, and when this occurred, it would exude serum or blood, and another scab would surely form. If the system became suddenly depressed from any cause, it would almost always assume the ulcerative process, and become a sloughing ulcer, which only healed with the general improvement of the system.

As thus described, this disease has prevailed in the Army of Virginia, both in field and hospital. The Surgeons of the Army of the Southwest, report its prevalence there. It was developed, in the early part of the year, in a Cavalry Regiment in the mountains of Virginia, the Colonel commanding suffering severely from the dis-

ease. In every case, its origin has been traced to the introduction of vaccine virus into the system. How far an epidemic cause may have exerted its influence in its early development, it is impossible even to surmise; we know, however, that it originated in Virginia, at a time when our Army was upon very short rations, and that many of the soldiers sent from the field at that time presented a decidedly scorbutic appearance. Many had been reduced and were broken down by exposure to the inclemency of a cold winter, and the depressing influences of low diet, want of clothing, and many other prolific causes of disease, calculated to deprive the blood of its healthy constituents, particularly of its fatty matter. Hence this may have produced a predisposition. In verification of this fact, I will state, that when it was found how frequently the disease in consideration supervened upon Vaccination in this hospital in broken-down and depraved constitutions, it was deemed prudent to postpone the introduction of the virus until the patient was restored to a healthy condition by improved diet and medical treatment. At the first appearance of the evil consequences of Vaccination, I was inclined, with other Surgeons, to believe that the virus was impure, and, because of this suspicion, I threw away the matter we then had, and obtained a vaccine scab from Dr. Knox a practitioner on Church Hill, who assured me he had used it in several cases with a perfect result.

The introduction of this virus into the arms of some ten patients resulted in the development of the disease in question in three of them, while in the remainder it produced apparently a true pustule. From this fact, and the immunity which healthy looking men enjoyed, I was led to believe that the predisposing cause existed in a vitiated and impoverished condition of the blood, and so reported in my first report, and that the introduction of pure virus into the system was the exciting cause of a latent disease. This view, I see, is also held by Surgeon Frank A. Ramsey, of the Department of East Tennessee, in a communication on file in office of Surgeon General. This view I have never had reason to change, though I am aware that many men, apparently in health, have suffered from the effects of Vaccination.

In one case, which I here quote, the influence of a good condition of the general system seems to have exerted a wonderfully modifying influence.

Case No. 23.—J. L. Turner, a private, Company G, 5th Virginia Cavalry, aged 37, married, parents healthy—he himself enjoying good health—never had any venereal disease. Entered the service, April, 1861—has been in service ever since, was vaccinated about a month ago, when in Hospital at Farmville.

This patient, Turner, was vaccinated last winter by Assistant Surgeon Valden, of this Division. It not having any effect upon his system, and feeling assured from this and previous Vaccinations that he was proof against the effect of it, he insisted upon being vaccinated by Assistant Surgeon Moses, from the effects of which he has suffered since, and for which he was on the 8th September admitted to this Hospital, presenting the following appearance: A number of pustules, resembling Impetigo, on left arm and leg, which were developed in successive crops, appearing as soon as the original pustule began to heal. This was a remarkably mild form of the disease, and was improving on Cod Liver Oil, when he was furloughed on the 20th September, being a paroled prisoner. This patient was young, vigorous, and comparatively healthy, when he received this Vaccine into his system.

MATTER FROM PATIENTS WHO HAD BEEN PREVIOUSLY VACCINATED, AND WHO WERE PARTIALLY PROTECTED, OR WHO WERE AFFECTED WITH SOME SKIN DISEASE AT THE TIME OF THE INSERTION OF THE VACCINE VIRUS.

Whilst it might admit of debate, whether pure vaccine virus obtained from persons never before vaccinated, and who manifested all the phenomena of the disease, and especially the characteristic febrile phenomena, ever becomes deteriorated or possessed of deleterious properties in its passage through numerous human bodies, not suffering with such a contagious disease as syphilis; on the other hand, it cannot be denied that the protective power of vaccination has been impaired to a lamentable and almost incalculable extent, by a succession of imperfect vaccinations; and especially by the employment of matter from those who have been previously vaccinated, or who have suffered from small-pox previous to vaccination.

Vaccination may be rendered imperfect by the development of febrile and other diseased states after the introduction of the virus into the system, arising from the action of cold, or some cause producing constitutional disturbances differing essentially from the febrile phenomena which mark the progress and perfection of the vaccine disease; as well as by its imperfect and altered course in those who are partially protected by previous vaccination.

In the isolated condition of the Southern Confederacy, cut off from the surrounding world, and denied even vaccine matter, as "*contraband of war*;" with the necessity of turning out the entire fighting population to repel invasion, and with the necessity of employing all the available medical aid, good, bad, and indifferent; and with the progressive increase of small-pox; it is not strange that the process of vaccination was not as carefully watched and tested as it should have been: and that consequently much imperfect material circulated as *vaccine matter*, which not only afforded little or no protection against small-pox, but also proved positively deleterious.

My friend and colleague, Professor Paul F. Eve, M.D., of the University of Nashville, has recorded in his discussion of certain

questions relative to the health of the late Southern Army, interesting observations upon Spurious Vaccination; and it will be seen, from the following extracts, that this distinguished surgeon, inclines to the belief, that the abnormal manifestations of the vaccine disease, may be due, in a great measure, to the alteration of the matter in consequence of its passing through a long succession of human subjects, and in consequence of the co-existence of various diseases.

"The scab used in Atlanta, which did so much mischief, was soft, porous, and spongy, of a yellowish brown color, resembling concrete, inspissated pus. It was not a small, hard, compact, translucent substance, like dried compressed glue, of dark mahogany color, requiring, as the genuine scab does, considerable effort to break it; neither did it present the clear, even, vitreous aspect when fractured, but was bulky, irregular and crumbling. In every instance, wherein vaccination was attempted with it, premature effects were developed. No proper period of incubation, nor papular or vesicular eruption was observed, but in a few days, even as early as the second, inflammation had set up, and by the fourth or fifth day, sores were produced, covered by a thick, dirty crust, with an ichorous discharge. Soon an ill-constituted ulcer, with perpendicular edges, ensued, extending through the dermoid to the cellular and muscular tissues, and involving the neighboring lymphatics. The cutaneous surface suffered chiefly, presenting large, irritable, very dark colored and scabby ulcers. Sometimes there was one, in other cases several, not on the extremity only into which the matter had been inserted, but on the others, and sometimes on the body. These cases were greatly aggravated by complications with erysipelas, scorbutus, syphilis, itch, etc. I believe we had no death from an uncomplicated case of Spurious Vaccination, though forty to fifty patients were treated in this hospital. * * * While every deviation from the regular development of the vaccine disease may be considered spurious, we yet understand now by that term, a pretty well defined, certainly a peculiar, if not a specific affection, which we have already attempted to describe. * * *

Intimately connected with the nature of spurious vaccination, is involved the question of its being simply a local affection, or constitutional disease. To what are its symptoms due; to a virus, or do they arise from cachexia? I am free to confess that the investigation of this subject has caused me to reverse the opinion, that the effects of impure vaccination are alone to be attributed to the bad condition of the patient's system, and did not depend upon anything special or specific. From repeated experiments, it is well ascertained that laudable pus when inserted into a healthy person is innocuous, and should it be used even in a decomposing or concrete state, will not excite certain uniform and peculiar results. Impure blood, peculiarity of constitution, indulgencies, epidemic influence, etc., etc., will account I know, for many local disturbances, but not for the origin of spurious vaccination. In every case it is the result of vaccination with impure virus, by careless or inexperienced persons. In reference to the nature of this impurity, there is good reason to believe that it results from a perversion or modification in the vaccine vesicle. We know heat destroys vaccine, as well as varicellous virus, and it may be that excessive inflammatory action changes the genuine vaccine matter into the

spurious. Of it may be this virus affected by another disease, or the bad state of the system, or becoming nearly effete itself, by passing through numerous systems produces a disease only resembling the true vaccine. The difficulty of developing genuine vaccination in one once impressed by the spurious, shows plainly the connection between the two.—*The Nashville Journal of Medicine and Surgery, New Series, Vol. 1, 1866, pp. 21-23.*

It will be seen from the following interesting communication, that Doctor Hamilton, of Chattanooga, who enjoyed ample opportunities for the investigation of the accidents following vaccination in the Confederate Army, attributes much of the spurious vaccination, to the careless use of matter from imperfect vesicles or sores.

CHATTANOOGA, Jan., 15, 1866.

PROF. JOSEPH JONES: DEAR SIR:—Your note of the 5th was received some time since. Sickiness, absence from home, and professional duties have prevented an earlier reply, which I much regret, but cannot remedy.

In regard to the subjects named, I fear I can afford but little information worthy of your consideration.

Of what is termed "Spurious Vaccination," I saw many instances during my service as Surgeon in the army; and while in charge of the General Hospital at Strawberry Plains, East Tennessee, I was directed, from the Surgeon General's Office, to make a statistical report of all cases which had come to my knowledge. In obedience to this order, I had collected notes of many cases, but shortly after came the evacuation of East Tennessee, and my engagement in a different field of labor, so that the report was not made, and most of the notes which I had accumulated were "lost or destroyed by unavoidable accident."

From the few notes I have on hand, and from such facts as I can recall to memory, I give you herewith the general results.

All the cases, with a few exceptions, of "Spurious Vaccination," which came under my observation during the war, were reducible to one of the three following named classes:

1st. A single suppurating ulcer at the point of vaccination.

2d. General eruptions, sometimes single, sometimes in patches involving a considerable extent of surface, appearing during the existence of the original ulcer, or after it had healed.

3d. General eruptions attended by suppurations of the lymphatic glands.

To what extent these different forms may be regarded as separate stages of the same development, I am not prepared to say, and I believe that no connection exists between them in such a sense. There certainly was no discoverable progression through the different conditions, such as is seen in some diseases.

It is evident that the result of any vaccination or inoculation must depend upon one or both of the following causes:

1st. Upon the kind of virus used.

2d. Upon the condition of the patient.

If vaccine virus is not used in any particular instance the result will be useless and perhaps hurtful to the patient. I am forced to the conclusion that a large majority of the cases of "Spurious Vaccination," which came under my observation during the war, were such because of the spuriousness of the virus used. If, by supposed vaccination, a "sore" was produced on the arm, the virus was supposed to be "taking," and straightway the matter was put into other areas, and other "sores" produced, when, on examination it would be found that not one of the arms gave evidence of vaccination. The pustules did not possess the characteristics of true vaccine, either in their progress or in their results. The proper scar was not left by them, nor the usual protection from variola afforded. A portion of liquid or encrusted pus, or of epithelium, was inserted in the arm, and the patient was presumed to be vaccinated. In some instances true vaccine virus was used on persons whose systems were protected by previous vaccination, and the matter from the resulting pustules, when used with others, became a source of evil. Soldiers practiced upon themselves from the arm of one of their number, whence came a long train of evil results.

But there were instances where portions of the same scab, produced in some persons the true vaccine pustule, and in others only the spurious eruption, and the explanation must be found in the condition of the patient. Just what this peculiar condition is, or what its causes are, we know not. The questions concerning the influence of army life on the physical, mental and moral condition of men recently taken from the walks of civil life, are many and various, and as yet, I believe most of us are only "guessing" at answers. Every medical officer remembers how fatal among soldiers, at times, were complaints which are ordinarily remediable, and that too, when, at the time of the appearance of the disease, the soldiers were apparently in robust health. It will also be remembered how very few instances occurred of what would be regarded as types of any one disease, while at the same time a large number of cases would be found. Nearly all were more or less modified, and some so completely as almost to lose their identity. But this subject is too extensive for discussion at this time.

In regard to the transmission of syphilitic poison through the process of vaccination, I can recall to mind a few instances, where I feel positively certain that secondary syphilitic eruptions existed, and the patients were equally positive in their expressed belief that the symptoms came from vaccination. Such cases were always diagnosed as syphilitic, and treated and relieved as such. My experience leads me to put so little faith in the assertions of persons affected with any venereal disease, on this subject, that I have arrived at no reasonable conclusion, and I can only say with the poet—begging pardon for so unpoetic a connection—"Though I cannot see, I guess and fear."

To sum up, then, in a few words. First—It is my belief that most of the cases of so-called spurious vaccination resulted from the fact that vaccine virus was not used, and therefore no vaccination, in the proper sense of the term took place. Secondly—The condition of the system, affected by atmospheric influence, or the kind of life led by soldiers, or by what you will, so modified the action of the virus as to produce morbid results.

I regret that circumstances prevent a more extended consideration of the subject touched on in this letter, such as their importance demands, and I rejoice to learn that you are preparing a Monograph on the same, and I shall look forward with much interest for its appearance in print.

Very truly yours,

R. D. HAMILTON.

Dr. Jenner in the beginning of his inquiries, felt the propriety of watchfulness; and at an early day he distinctly announced that it was possible to propagate an affection by vaccination conveying different degrees of security, according as that affection approached to, or receded from, the full and perfect standard; he also clearly stated that the course of the vaccine pustule might be so modified as to deprive it of its efficacy, and that inoculation from such a source might communicate an inefficient protection, and that all who were thus vaccinated were more or less liable to subsequent small-pox. He still farther maintained that fluid taken from a genuine pustule in its far advanced stages, is capable of producing varieties which will be permanent if we continue to employ it. Dr. Jenner attached great importance to the condition of the skin at the time of the insertion of the virus.

In his tract "On the Varieties and Modifications, of the Vaccine Pustule occasioned by an herpetic state of the skin," he says, "I shall here just observe, that the most careful testimonies now lie before me supporting my opinion that the herpetic, and some other irritative eruptions, are capable of rendering variolous inoculation imperfect, as well as the vaccine."

One of the entries in his Journal is to the following effect: "Inoculated Lady C. F. a second time. It is very evident that that affection of the skin called red-gum, densens the effect of the vaccine virus. This infant was covered with it when inoculated four days ago. The same thing happened to Mrs. D's infant."

In a letter to Mr. Dunning, dated Berkely, Dec. 23, 1804 Dr. Jenner says:

"There may be peculiarities of constitution favorable to this phenomenon. My opinion still is, that the grand interference is from the agency of the herpes, in some form or another; for I have discovered that it is very Proteus, assuming, as it thinks fit, the character of the greater part of the irritative eruptions that

assail us. I shall have much to say on this disease one of these days."

The reported failures of vaccination, and the occurrence of several violent variolous epidemics in different parts of the country, induced him to endeavor to rouse the attention of professional men to those points, in the practice of vaccination which he deemed essential to its success. With such intentions he printed a circular letter early in 1821, which was sent to most of the respectable medical men in England; in it he directed their observation to the three following questions:—

"First. Whether the vaccine vesicle goes through its course with the same regularity when the skin is under the influence of any herpetic or eruptive disease, as when it is free from such affections; secondly, whether the existence of such eruptive diseases causes any resistance to the due action of vaccine lymph, when inserted into the arms; thirdly, whether cases of small-pox, after vaccination had occurred to the observer; and if so, whether such occurrences could be ascribed to any deviation in the progress of the vaccine pustule, in consequence of the existence of herpetic, or other eruptions, at the time of vaccination."—*The Life of Edward Jenner, M.D., LL.D., F.R.S., &c.*, by John Baron, M.D., vol. ii. p. 272.

The answer to these inquiries, by the Rector of Leekhamstead, contains facts of such value in their bearing upon this portion of the subject, that we are induced to reproduce it entire:

LEEKHAMSTEAD, NEAR BUCKINGHAM, June 29th, 1820.

EDWARD JENNER, M.D.: *Dear Sir*.—Your letter did not reach Buckingham till June 23rd, though dated the 12th. The object of inquiry appears to be the extent to which cutaneous diseases reject or modify the vaccine virus, so as to render the efficacy and security doubtful. I have looked over a number of copies of communications to Dr. Harvey, and with great pleasure send you the transcripts of the interference of variolous and vaccine infection, and the superseding power of the latter if applied in time, six of which took place at Old Stratford in 1816, among the children of one family, being the whole time under the same roof. The distress and alarm at that time were extremely great, as the inhabitants were recovering from the measles when the small-pox broke out. The anxiety of the parents was such that I was induced, contrary to my own opinion, to vaccinate several where the fever of measles had not completely subsided: the consequence of which was nothing more than that the vaccine virus lay dormant in its cell till the field was

clear, and came into action two or three days later; but afterwards proceeded in as regular and decided a manner as in constitutions which were not previously engaged.

I discovered at a very early period that the itch was not an impediment; as to the shingles, I cannot speak. The grand rejecting agent in children is the tooth rash; or, as it is here commonly called, the red gum, especially while it continues bright and active. Dr. William Cleaver (when Bishop of Chester) promoted an extensive variolous inoculation in his diocese. Some years after, he asked me if I could account for the very frequent failure of communicating the infection to young children. I told him that it applied equally to the vaccine; though frequently, if the virus was fresh and active, it would be suspended in its career for a time only, but push forward with success at last.

I beg to assure you, Sir, that nothing I have met with has, in the slightest degree, shaken my faith in the vaccine. I have seven children, the eldest sixteen, all vaccinated by myself; and of 14,305, all within a few miles of this place, I have never heard of a single fatal disappointment; and of only two or three cases of modified, or what I should feel inclined to call superficial, or cutaneous small-pox. As to remote or derivative diseases, I know of no such thing fairly to be ascribed to the cow-pox; I have ample means of knowing if such a thing had taken place, as the people of my two parishes, and many in the neighborhood, are, somehow or other, continually coming under my consideration for medical assistance. My communications of late years have been to Dr. Harvey according to the directions of the National Establishment; but I have met with no demand for inoculation since February 1820, simply from the absence of any stimulating alarm.

I am dear Sir, with the highest respect,

Your most obedient humble servant,

T. T. A. REED, Rector of Leckhamstead.

Mr. Reed had, in 1806, printed and distributed a tract for the encouragement of those who entertained any doubt respecting the efficacy of vaccine inoculation; and distinguished himself as an ardent and successful promoter of vaccination; his testimony, therefore, is of great value.

Dr. Jenner maintained to the last hour of his life, that any cutaneous disease, however slight in appearance, was capable of interfering with the regular course of the cow-pox, and of preventing it from exercising its full protecting influence; and his directions for obviating any deterioration of the virus, regarded first, the character of the pustule itself, the time and quality of the lymph taken for inoculation, and all other circumstances that might go to affect the complete progress of the disorder. Thus he maintained that the vaccine fluid should be

taken, for the purpose of inoculation, at an early period of the formation of the vesicle, and before the appearance of the areola; and he insisted that the pustule, when excited, should be permitted to go through all its stages in an uninterrupted manner, and if any deviations appeared in its progress, he always forbade the employment of virus from such a pustule for further vaccinations.

Dr. Waterhouse, in a letter to Dr. Mitchell, dated Cambridge, Sept. 26th, 1801, says: "Yesterday I received a letter from Dr. Jenner, one paragraph of which I must transcribe, because it contains the *golden rule of vaccination*, viz: 'I don't care what British laws the Americans discard, so that they stick to this—*never to take the virus from a vaccine pustule for the purpose of inoculation, after the efflorescence is formed around it.* I wish this efflorescence to be considered as a sacred boundary, over which the lancet should never pass.'—*Med. Repository*, N. Y., vol. v., p. 236.

Every deviation, from whatever cause it may have arisen, was considered by Jenner of the greatest moment; and as has been fully shown by the learned author of his life, in all his published works, as well as in every private communication, he never failed to express his deep sense of the importance of the most scrupulous attention to that part of the subject; and to the last he felt that, had his admonitions been received as they ought, had the phenomena connected with vaccine inoculation, been studied by all who conducted the practice, a large proportion of the failures would have been avoided.

The following important and interesting communication, published about forty-five years ago, confirms, in a striking manner, the correctness and great value of the laws laid down by Jenner, with reference to the relations of the vaccine disease to cutaneous affections:

OBSERVATIONS ON THE VACCINE AND VARIOLOID DISEASES. COMMUNICATED BY JAMES DAVIS, M.D., OF COLUMBIA, SOUTH CAROLINA.

I offer you the following communication, not only because it seems to corroborate the observations of Dr. Jenner and others, that the simultaneous existence of cutaneous diseases, with the vaccine pox, has a tendency to vitiate the virus of the latter

disease, and render it unfit for communicating the true kine-pock; but, moreover, because it would appear that the vaccine matter is liable, from this circumstance, to be converted into a virus of a totally different character. * * *

I extract the following case from my note book:

On the 29th of June, 1814, I vaccinated Master James D. Montgomery, *et. 18* months, son of Dr. B. R. Montgomery, Professor of Moral Philosophy, &c., in the South Carolina College, together with six other healthy children. I had obtained the matter that I made use of from Dr. Smith of Baltimore. James D. Montgomery had been laboring under a cutaneous disease (the *strophulus interictus* of Willan) for about three months. It had resisted every remedy which I had prescribed for it, and by this time had literally spread over the whole surface, so as to render it difficult to find a sound spot on the arm, large enough for making the insertion. I should have been deterred from vaccinating in such a case, but for a remark of Dr. Jenner, *viz.*: "That vaccination, although not very certain to take in cases of cutaneous eruption, yet, when it did take, it was curative of the cutaneous disorder." Upon this information, I recommended it to Dr. Montgomery, who readily acceded to the experiment. The vaccine failed to take effect in every one of the cases, except in that of J. D. Montgomery; and in his case, it was really gratifying and delightful to observe the effect of it on the cutaneous disease. As the vaccine-pock advanced, the affection of the skin disappeared, and that in a very exact proportion to each other; so that, by the time the pock was mature, the cutaneous disorder had entirely gone off. From fifteen to twenty-five days after the kine-pock had been in its full course, he was afflicted with two abscesses, one on his back, and one on his breast, which discharged from half an ounce to an ounce of laudable pus; since which time he has remained in sound and perfect health.

His pock proved to be anomalous, and whether it were sufficient to protect his system against the small-pox has not since been tested. But from the constitutional symptoms which I attentively observed, I am very much inclined to believe, that as to himself, it was effectual.

The virus manifested no signs of having taken effect until the eighth day, when the small inflamed point at the puncture first appeared.

The areola did not progress from day to day with regularity, nor was it at any time sufficiently circumscribed, having some radii considerably longer than others. Its color was a coarse red, instead of that beautiful fine blush, which the genuine vaccine generally exhibits.

The pock, although of ordinary size, and of a concave surface, was destitute of that cordon of bead-like vesicles, which form around the coroga of the true kine-pock. It was peculiarly dry, inasmuch that it was difficult to obtain from it as much lymph as would serve for further vaccination.

Four healthy children (white and black) of the family of Dr. E. D. Smith, Professor of Chemistry, &c., were vaccinated from this pustule. I had expressed an opinion, that although I believed the constitution of little Master Montgomery was secured against the small-pox, that, nevertheless, I doubted of the efficacy of the matter of his pustule to communicate the true disease. As matter, however, was hard to be obtained, and as it was conceived no danger could result from it, the Doctor determined on making the trial. It failed to produce any effect whatever on all, except on one of the Doctor's own children. In this case the puncture began

to inflame within the first fourteen hours. The inflammation spread rapidly, accompanied with innumerable papulous eruptions over the inflamed surface, exuding a profuse quantity of gelatinous matter. It continued to spread for about thirty hours, assuming in its progress rather a formidable appearance, and exciting a good deal of alarm, until it occupied a space longer than five or six areolas of the true pock; extending over the one more longitudinally than laterally. Apoplectic were administered, and the topical affection fomented with a decoction of chamomile flowers, and in about forty-eight hours it had totally disappeared, having exhibited no sign whatever of any thing like a pock. There was no constitutional disturbance accompanying the affection. The child remained in perfect health, and has undergone the kine-pock by a subsequent vaccination.

This case evinces two facts in a clear and decided manner, to wit: that the vaccine disease is capable of effecting the cure of certain inveterate diseases of the skin; and that certain diseases of the skin may exert such an influence over the vaccine matter, as not only to vitiate and render it unfit for communicating the true kine-pock, but also absolutely to change and convert it into a poison of a new and unknown character. Two facts of great practical importance, and which perhaps, deserve more investigation and scrutiny, than they have hitherto received.

The influence of kine-pock over cutaneous disorders, is an old remark; and the influence of diseases of the skin in vitiating the matter of the kine-pock, and rendering it unfit for communicating the true pock, is equally old. But its liability to be converted into a poison of a different nature, productive of singular and anomalous affections, in consequence of being blended with certain cutaneous disorders, is a subject which has not hitherto attracted as much attention as it merits. In this instance, the cutaneous disease of Master Montgomery, obviously occasioned a conversion of the vaccine matter into a new kind of virus, producing a new and singular affection. It is true, it proved to be a mere topical affection, and terminated without any serious consequences; but, as the vaccine matter is liable to be changed by one form of cutaneous disease, is it not reasonable to conclude, that it may also be changed by others? And although, in this particular case, it was changed into comparatively an innocuous virus, have we any evidence, that in blending with some others of the multifarious affections of the skin, incident to mankind, it may not become converted into a virus of deleterious and destructive operation?

All this however, indicates nothing against the utility and importance of *genuine* vaccination, but only shows how important it is that it should be practiced with a care, circumspection, and skill, with which the prevailing custom of our country at present is utterly incompatible; and until there shall be a reform effected in this respect, it will be in vain to look for the full extent of those beneficial results to mankind, which the kine-pock is unquestionably calculated to afford.

The attainment of these results in strict conformity with the laws of our condition in the attainment of every other great and important good, is beset with difficulties; nevertheless we have no reason to suppose that these difficulties are insuperable. Every year brings to light some new facts, which enable us to approach nearer and nearer to the attainment of the desired object. And as one principal obstacle to the improvement of our knowledge of this subject has been the apathy, indifference, and even levity with which it has been received by a great majority of the community; so, when, perhaps from severe afflictions and scourges, or from any

other causes, this supineness and indifference shall be removed; then the mare of improvement will be rapidly accelerated, and great and permanent advantages will be the happy result.

Would it not be a wise precaution, and worthy of legislative provisions, to impose a penalty on any one who should communicate the vaccine disease from an unhealthy subject?—*The American Medical Recorder of Original Papers and Intelligence in Medicine and Surgery, conducted by John Eberle, M.D., Philadelphia, and H. W. Du Rochet, M.D., New York, vol. v., 1822—pp. 268-272.*

The power of the vaccine virus to relieve diseases of the skin, can only depend upon its absorption into the blood, and its effects upon the entire system: and facts are not wanting to show by actual manifestations of the local disease in other parts of the system not inoculated with the virus, that the entire system as well as the skin is brought under the action of this poison.

Dr. Denby, reported the case of Henry Freeman, a lad of twelve years of age, who was vaccinated in the left arm by the usual mode. The vesicle was marked by the appropriate progressive character of successful inoculation. It happened that on the same day on which he was vaccinated (five hours subsequent to that process,) an incised wound was accidentally inflicted on his right knee; which wound, for two or three days promised union by the first intention. On the fourth or fifth day, however, an increase of pain was felt in the knee, with throbbing and heat about the edges of the wound; and, on inspection, some slight papulae, to the number of ten or thirteen, were observed surrounding it. These appearances were yet referred to a common cause. On the eighth day, their peculiar and regular form imparted a conviction that they were true vaccine vesicles, which they proved to be by their progress and maturation.—*London Med. Press, April, 1825.*

As far as our knowledge extends, the records of Medicine, are singularly barren of critical observations upon the phenomena manifested by man, when acted upon, by two or more diseases at the same time. This imperfection of knowledge results not only from the complexity of the phenomena, and the difficulties of the investigation, but also from the comparatively infrequent occurrence of two or more contagious diseases, at the same time, in the same household, and in the same individual.

Every fact illustrating the relations of the vaccine disease, to other diseases arising simultaneously in the same individual, is of importance in the light which it throws upon the modifications of the vaccine disease, and upon the question of the possibility of transmitting various contagious diseases through the medium of the vaccine virus.

The following facts and observations by various writers, bearing upon these questions, which we have gathered up after some research, are presented under this division of our subject, to which they naturally belong, rather for the purpose of exciting and aiding farther investigation, than as full and complete investigations upon which definite and uncontrovertible principles may be founded. I have myself conducted extended investigations upon the mutual relations, of various concurrent diseases, as Malarial Fever, Typhoid Fever, Pneumonia, Cerebro-Spinal Meningitis, Hospital Gangrene and Pyæmia, the results of which it would be impossible to present at the present time, although related to the subject now under discussion; and I shall present those facts which relate chiefly to the relations of Small Pox and the vaccine disease to several of the Exanthemata.

If we accept without reserve the doctrine of John Hunter, that "No two actions can take place in the same constitution or in the same part, at one and the same time: no two different fevers can exist in the same constitution, no two local diseases in the same part, at the same time;" (*Works of John Hunter, edited by James F. Palmer London 1837 vol. ii., Treatise on the venereal disease, p. 132*): the question of the modification of the vaccine disease by concurrent diseases, as well as of the possibility of the transmission of contagious diseases through the medium of the vaccine virus is definitely settled in the negative. The unreserved assent to such a doctrine as this, is wholly incompatible with the admission of the possibility of transmitting such a disease as Syphilis through the medium of the matter produced by a distinct disease, different in its mode of origin, constitutional action, symptoms and progress.

Even the renowned author of this doctrine, appears to have experienced difficulties, when he attempted to apply it univer-

sally. The engrafting of other diseases upon the systems of those who were laboring under constitutional syphilis, and scurvy, as well as the occasional occurrence of these two diseased states in the same individual, presented at the outset difficulties to the mind of John Hunter, which he attempted to remove by argument. The mode, as well as the facts, by which Hunter supported his doctrine are worthy of full consideration, in this connection, as gathered from various portions of his works.

"Of diseased Actions, as being incompatible with each other.—As I reckon every operation in the body an action, whether universal or partial, it appears to me beyond a doubt that no two actions can take place in the same constitution, nor in the same part, at one and the same time; the operations of the body are similar in this respect to actions or motions in common matter. It naturally results from this principle that no two different fevers can exist in the same constitution, nor two local diseases in the same part. There are many local diseases which have dispositions totally different, but, having very similar appearances, have been supposed by some to be one sort of disease, by others to be of a different kind, and by others again a compound of two diseases. Thus the venereal disease, when it attacks the skin, is very similar to those diseases which are vulgarly called scurvy, and *vice versa*. These, therefore, are often supposed to be mixed, and to exist in the same part. Thus we hear of a pocky-scurvy, a pocky-itch, rheumatic-gout, &c., &c., which names, according to my principle imply a union that cannot possibly exist.

"It has been considered as contradictory to this opinion that a patient might have scrofula, scurvy, venereal disease, small-pox, &c., at the same time. All of this is indeed possible; but then no two of them can exist in the same part of the body at the same time; but before one of them can occupy the places of another, that other must be first destroyed, or it may be superseded for a time, and may afterwards return.

"When a constitution is susceptible of any one disease, this does not hinder it from being also susceptible of others. I can conceive it possible that a man may be very susceptible of every disease incident to the human body, although it is not probable; for I should believe that one susceptibility is in some degree incompatible with another, in a manner similar to the incompatibility between different actions, though not of so strict a kind.

"A man may have the measles and the small-pox at the same time; that is, parts of his body may be contaminated by the venereal poison, the small-pox may at the same time take place, and both diseases may appear together, but still not in the same part.

"In two eruptive diseases, when both are necessarily the consequence of fevers, and where both naturally appear after the fever nearly at the same distance of time, it would be impossible for the two to have their respective eruptions, even in different parts, because it is impossible that the two preceding fevers should be coexistent.

"From this principle I think I may fairly put the following queries: Do not the failure of inoculation, and the power of resisting many infectious, arise from the

existence of some other disease at that time in the body, which is therefore incapable of another action?

"Does not the great difference in the time, from the application of the cause to the appearance of the disease, in many cases, depend upon the same principle? For instance, a person is inoculated, and the puncture does not inflame for fourteen days, cases of which I have seen. Is not this deviation from the natural progress of the disease to be attributed to another disease in the constitution at the time of inoculation? Does not the cure of some diseases depend upon the same principle?—as, e. g. the suspension or cure of a gonorrhoea by a fever.

"Let me illustrate this principle still further by one of many cases which have come under my own observation. On Thursday, the 16th of May, 1775, I inoculated a gentleman's child, and it was observed that I made pretty large punctures. On the Sunday following, viz., the 19th, he appeared to have received the infection, a small inflammation or redness appearing round each puncture and a small tumor. On the 20th and 21st, the child was feverish; but I declared that it was not the variolous fever, as the inflammation had not at all advanced since the 19th. On the 22d, a considerable eruption appeared, which was evidently the measles, and the sores on the arms appeared to go back, becoming less inflamed.

"On the 23d he was very full of the measles; but the punctures on the arms were in the same state as on the preceding day. On the 25th, the measles began to disappear. On the 26th and 27th the punctures began again to look a little red. On the 29th the inflammation increased, and there was a little matter formed. On the 30th he was seized with fever. The small-pox appeared at the regular time, went through its usual course, and terminated favorably." (Vol. iii., Treatise on the Blood, Inflammation and Gunshot Wounds—pp. 3-5.

"All diseased actions are simple.—A disposition of one kind may and shall exist in a part or whole, while an action of another kind is going on; and when the action ceases, the disposition, or dormant action, if we may be allowed to call it so, shall then come into action. * * *

"Two children were inoculated for the small-pox. Their arms inflamed; but about the third or fourth day from the inoculation symptoms of fever arose, and the measles appeared, and went through their progress as usual. During this time the inflammation in the arm was arrested; but when the measles were completely gone, the small-pox took place, and went through its progress.

"Here a disposition for the measles had taken hold of the body, but although it had done that previously to the small-pox, yet it was not in such a way as stopped the progress of the small-pox. The small-pox matter was capable of contaminating, and produced inflammation, which went to a certain length, but the moment the measles changed their disposition into action, as the two actions could not go on together, the action of the small-pox was suspended till the measles had gone through its action, and the moment the constitution got free of this, the small-pox began to act again.

"A lady of rank was inoculated by Mr. Sutton. A few days after a fever came on, of the languid or putrid kind, but without any eruption, except a few petechiae on the breast: she went through the process of a low fever, and afterwards the small-pox commenced: yet when the pustules matured they spread and were very

large; also a different set of eruptions succeeded, so that thirty days passed before the skin was clear of the eruptions.

"These cases show that but one mode of action can take place at the same time; yet I could conceive that two actions might produce a third one, which might have been a new poison, as the last case in some measure seems to show." (Vol. i. Principles of Surgery—pp. 312-313.)

Dr. Joseph Adams, in his valuable Observations on Morbid Poisons, Chronic and Acute, (London, 2d Ed. 1807,) advocated the doctrine of Hunter, that "Two actions cannot be carried on at the same time, or in the same constitution." And recorded in his work the following observations to sustain this proposition.

"Though the law was entirely overlooked till Mr. Hunter's time, yet it is now as well ascertained as any other in pathology. It is worth remarking, that in all the epidemics described by Sydenham, in which small-pox and measles raged at the same season, he gives no hint of their ever appearing at the same time in the same person. Dierembroek, indeed, mentions a solitary instance in which the two diseases took place at the same time. His son remarks on the passage, that he never met with a similar instance more than twice in his own practice. Dierembroek's account is somewhat confused. It should be remarked, too, that measles was at that period not so distinctly marked as in later times, and that with the small-pox and other exanthemata, an unusual efflorescence, which may be mistaken for measles, is not uncommon. We have, however, two cases given us by that close observer, Dr. Russell, (*Medical and Chirurgical Transactions*, vol. ii. p. 90), which from the reputation of the author, deserve particular notice. The series and order of symptoms are traced with such accuracy, as not only to place the fact beyond a doubt, but to enable us to make remarks without conjectures, or with only such as every reader will see are admissible.

"We shall first observe, that when in the ill-built and crowded city of Aleppo, small-pox and measles were at the time epidemic for three months together, only two such cases occurred. In both these cases, the measles were of a formidable kind. It is now established, that if measles do not produce their full action, they sometimes occur a second time. (See Dr. Willan's Diseases of London, p. 207.) It would be a curious enquiry, if there were any chance that it could be satisfied, to learn whether, on a future epidemic, these children took the measles again. However, those who know how few laws in pathology are without any exception, will only be surprised that this should so rarely occur.

"Dr. Setteson (Mem. of Med. Society, vol. iv., p. 288), relates the history of a family, consisting of the parents, eight children, and three servants, among whom scarlatina and measles appeared about the same time. Some had measles first, others scarlatina. All had the latter, and as many as had not gone through them before, had measles. In consequence of this succession, adds the Doctor, the diseases continued in the family for two months, which probably might have terminated in as many weeks; but no person had the two diseases at the same time, so far, at east, as could be ascertained by the symptoms."

The industrious De Haën, wishing to discover a common original cause for all the exanthemata, remarks that small-pox and measles usually become epidemic about the same time. Referring to his notes, he observes, "that in the year 1752, scarce a family but was visited by both diseases at the same time, yet each individual had the two diseases in succession—Vides successive fisdem in aedibus occupare infantes quorum alii morbillis, variolis alii laborere demum incipiunt.—*Est. Med.*, vol. i., page 102.

"Dr. Winterbottom, in a general vaccination, describes the retardation of that process, by the occurrence of measles, as an event too common to excite any particular attention. (*Med. Trans.*, vol. xiv., p. 25.) The same retardation was remarked by Dr. King, from the same cause. (*Med. Trans.*, vol. xiv., p. 167.) The same occurred to Mr. Wachsall, at a general inoculation in Walthamstow.

"Dr. Willan observes, that it is generally found the small-pox, measles, scarlet fever, and hooping-cough, become epidemic about the same time, and continue their progress, though not with equal violence. (*Diseases of London*, p. 105.) Yet of the three former he gives no instance in which two of them appeared at the same time in the same person. It is evident that this was not from any inadvertency, because we find the same accurate writer, on another occasion, observing that hooping cough and small-pox had occasionally occurred in the same person and at the same time. On this I would remark, that after the febrile paroxysm of hooping cough has subsided, the disease loses its specific character, and if the lungs have materially suffered, the cough may be exasperated by the variolous paroxysm. But Dr. Willan, in another place (*Diseases of London*, pp. 38-39) asserts, that in some instances hooping cough commenced during the small-pox eruption. If this fact had been furnished by a less accurate observer, I should have objected, that whenever hooping cough is epidemic, we have usually other severe coughs at the same time, which in children, are not easily distinguishable from hooping cough. But admitting the accuracy of the statement, it only proves, as Dr. Willan observes, that the law, though very general, is not without any exception. We have also his own authority, that in some instances the hooping cough was instantly superseded by small-pox, and after the decline of the latter, returned with the same violence as before. Mr. Osles (*Medical Journal*, vol. viii., p. 426) relates the case of a child whom he was under the necessity of inoculating with small-pox whilst under the hooping cough. The consequence was that as soon as the eruption appeared, the cough ceased, and never returned. The same has frequently happened after vaccination, and, I have reason to believe, permanently, as the cough has not returned, at least, ten days after the process of vaccination has been completed. This is now so generally understood, that many mothers have brought their children to the hospital for vaccination, under an expectation of curing them of hooping cough, and I do not recollect that any of them have been disappointed. However, I would never recommend it till the acute symptoms of the cough are passed, for, as till that time the full action of the disease is not over, it is reasonable to expect its return when the process of vaccination is completed.

"To those who are fond of tracing the operations of nature under disease, it will be curious to mark the exact regularity of the succession of these morbid poisons when they occur in the same subject. Mr. Hunter, (Introduction to Treatise on the Venereal Disease, and also to the Treatise on the Blood, &c.) found the variolous

insertion in his patient interrupted on the fourth day after the puncture was made, till which time it had proceeded regularly. On the day following, the morbillous fever commenced, and on the fourth day after that, the measles appeared. Four days afterwards, the measles began to disappear. During these eight days, the variolous insertion had made no progress; but on the following day it recommenced its process, and in five days afterwards the variolous fever commenced. Here the constitutional disposition was interrupted on the fourth day. On its recommencement, five days more were necessary before the action could take place, nine days being the medium between the insertion of small-pox and the commencement of the variolous fever.

"Mr. Cruickshank's case (Treatise on the Absorbent Vessels, p. 126.) appears to have been interrupted *ab initio*; for he found his patient with all the symptoms of morbillous fever on the ninth day after inoculation. The punctures of the arms, therefore, continued invisible till the constitution began to recover from the measles, after which time the punctures inflamed and required their full period of eight days for the appearance of small-pox.

"In a general vaccination at Walthamstow, two children were seized with the morbillous eruption on the eighth day after vaccination. In these the areola from that virus was suspended for four days. In a third, on the 10th day; and here the interruption to the process was only three days.

"But a most elegant experiment, in illustration of this subject, is contained in Dr. Willan's last number of Cutaneous Diseases. 'I inoculated,' says Dr. Willan, 'about the same time, three children with the fluid contained in these (lymphatic or miliary vesicles in measles), but no effect was produced by the inoculation. A similar trial, at the inoculation hospital, proved more successful. Richard Brooks, aged 18, was inoculated by Mr. Waschel, with fluid from the miliary vesicles in the measles, and with vaccine virus, January 6, 1800. On the 10th, there was some redness and ulceration in both the inoculated places. January 15th, the redness round the part, where the lymph of the measles was inserted, had disappeared, while the vaccine pock was vivid. January 18th, the vaccine disease was over. January 22d, he has a severe cough, sneezing, and watery eyes, with cold shiverings and fainting. January 28th, the measles appeared; his eyes were inflamed and the lids swollen. January 29th, the efflorescence was diffused all over the surface of the body; frequent cough and violent fever. February 1st, efflorescence disappeared; cough and fever much abated. From that time he gradually recovered, and was dismissed in health on the 12th of February.'

"This interesting passage, besides containing an account of the successful inoculation of the measles, affords also a striking illustration of the protraction of a disease, after the disposition of it had taken place, and its regular return to complete all its periods, as soon as the cause which interrupted them ceased. This subject was, at the same time, susceptible of the two contagions; and as long as the diseased actions were local, both went on at the same time in different parts. But as soon as the constitutional disposition commenced in one (the vaccine), the local action from the other was suspended. When the vaccine disposition and action were completed, the rubellous disposition commenced. Four days afterwards, the constitutional symptoms first showed themselves, with cough, sneezing, and watery

eyes.* In six days more the eruptive symptoms began, and were completed on the following day. On the fourth day afterwards, the efflorescence disappeared, and the symptoms abated, making, in the whole, about twenty-seven days, a fair allowance for the two diseases.

"The following laws, then, are to be admitted with as few exceptions as any others that are received in pathology.

"1st. All persons are susceptible of the impression from a morbid poison, in proportion as they are unaccustomed to it.

"2nd. That susceptibility and disposition are necessary in a constitution or part before the action excited by a morbid poison can take place.

"3d. That after the constitutional disposition has taken place from a local diseased action, the destruction of that local action will prevent the future appearance of the constitutional disease.

"4thly. That no two actions from two different morbid poisons can be carried on at the same time in the same part, or in the same constitution.

"5thly. If a constitutional disposition to one morbid poison exists, whilst the action of another is going on in the constitution, we ought to expect the action of the first to appear after the action of the second is completed, or has ceased.

"6thly. Though nothing can prevent an action from following after a disposition has taken place, yet a disposition may be prevented by preventing a susceptibility in the constitution or part.

"7thly. The susceptibility may be prevented by rendering the constitution familiar with the morbid poison, or, as long as the constitution is exposed to it, by keeping up a constitutional action previously excited by another morbid poison, or any other cause." (Adams on Morbid Poisons, pp. 21-23.)

Dr. Lundford, a native of Jamaica, who made Yaws the subject of his inaugural dissertation states that "those who are under the Yaws, are liable to the other exanthemata, such as measles and small-pox. The latter may be induced by exposure or inoculation, which last is better attempted when yaws is in the decline, for then the small pox will either entirely take away yaws, or at least will check it for some time; nor will the funguses continue long, even if they should happen to appear again on the surface."

Upon this observation Mr. Adams in his work on Morbid Poisons, remarks:

"All this is perfectly analogous to what has been traced in other morbid poisons. It is probable that the irritation from small-pox and measles, being greater than from yaws, may interrupt the latter at any time. But the laws of that poison, requiring a certain course to be pursued, if the new irritation is induced before that

* Dr. Willan considers the common period, after infection by effluvia before these symptoms appear, to be from six to ten days. The anticipation, in this case, by inoculation, is nearly analogous to the mean difference between inoculated and casual small-pox.

course is completed, the disease must return as that new irritation ceases. If, on the contrary, that irritation has not been induced till the course of yaws is completed, and nothing remains of it but an habitual ulceration, the new irritation will not only supercede the old action, but by breaking the habit, very much expedite the cure."

"Dr. Dancer, in confirmation of the above, gives the following quotation from Dr. Menbhard:—During the universal prevalence of the small-pox in this Island, in the year 1784, it was remarked, that several negroes, afflicted with yaws, who had the yawy pustules on the surface of the body, and had been a considerable time under all the afflicting circumstances of the disease, were inoculated promiscuously among many other negroes. The result was that upon the decline of small-pox, and dying away of the pustules, the yaws also gradually disappeared; as if both might be considered in the light of one congenial disease." (Adams on Morbid Poisons pp. 212-213.)

Dr. Delgrade, relates several cases of the simultaneous occurrence of small-pox and measles, which ran their course together. A child was inoculated with the matter: on the eighth day, this infant, after a slight indisposition, took the measles.

"On the fifteenth, having completely recovered from the measles she became very feverish. Between this and the twentieth, she had several convulsions. On that day small-pox appeared. The infant not having been near any other child with that disorder, it was thus proved not only that the eruption was variolous, but that the fever was infectious.

"Still the difficulty remained of accounting for its origin, since no small-pox was known to prevail in the neighborhood. The parents and neighbors could give no clue. Soon afterwards I heard that a child had recently died of combined small-pox and measles. Unable to trace this report, I concluded it was merely an erroneous account of the present case. Calling, however, with Mr. Daniell, on a female, one of his dispensary patients, she informed me that the child was her own. Of this case I can give no accurate narrative. The mother herself was dying, and the child had been visited by no medical attendant. Judging from the statement, I imagine the two disorders occurred in succession, not simultaneously. The child was taken ill some days before Brooke's and certainly died of small-pox. Yet even this was unsatisfactory, since the families lived at a distance from each other. No communication of the children was known, until I discovered that they had attended the same school, a circumstance of which their friends were mutually unconscious." (*Medical-Chirurgical Transactions, of London, vol. viii., Part I.*)

Dr. Russell in noticing the reciprocal influence of small-pox and measles, states that he carefully watched above 300 cases in which these diseases succeeded each other, at a time when they were both epidemic at Aleppo (1765). He noticed that

the measles rarely succeeded small-pox in less than 20 days from the first appearance of the eruption. Several cases occurred where small-pox succeeded measles before the total disappearance of rubeolous rash from the extremities, that is on the 11th or 12th day of the eruption. He adds, "so little did the quality of the first disease influence that of the second, that a mild distinct small-pox was often observed to follow the worst kind of measles, and vice versa." Wilan relates the case of a young man, aged eighteen inoculated for measles and cow-pox on the same day; the cow-pox took the lead, measles following at the end of sixteen days: and Dr. Gregory has described a case very analogous, but there measles had the start, and after sixteen days, cow-pox had its turn. Dr. Gregory calls attention to the fact, that in each case sixteen days was the period of suspension, and expresses his belief that this was not accidental. (Lectures on the Eruptive Fevers.)

Dr. Morland reported to the Boston Society for Medical Improvement the following interesting case:

On the 13th of February 1856, he vaccinated a healthy male infant, six months old. On the 17th of the same month, a faint but sufficiently distinct eruption of measles was observed about the neck and shoulders. The usual symptoms of rubeola had declared themselves on the next morning after the vaccination, and the disease, consequently, must have commenced only a few hours previously to that operation, if four days be adopted as the period elapsing between the attack and the appearance of the eruption. The vaccine vesicle matured very slowly for several days, and the rubeolous eruption continued with varying distinctness, but always comparatively slight, until the 19th, of February, when it disappeared. The vaccine vesicle then took a start, and went on rapidly to perfection. There seemed to be a retarding action reciprocally maintained for a time by the two affections, thus accidentally concurrent; vaccine finally prevailing. The circumstantial record made at the time reads thus:

"February 17th, vaccination apparently taking effect, measles appeared; will the vesicles be retarded? 18th, Vesicles advancing very slowly, measles retrograding; ordered a warm bath. 19th, Vesicles going on, but more slowly than is common;

less redness around it; eruption of measles gone; will it recur? 20th, Vaccine vesicle much larger; child feverish; warm bath. 21st, at 7½ o'clock in the morning, the child was seized with a severe general convulsion. He was seen by Dr. M. in about twenty minutes; a warm bath had been used. Wine of ipecac, and enemata, with cold lotions to the head, were at once resorted to, and subsequently, three grains of calomel with five of rhubarb were given. Aspect of the little patient pale and confused. At 1½ o'clock, P. M., he had another convulsive attack of rather greater severity. By previous direction, he was immediately placed in a warm bath, the body and limbs were well rubbed with the hands, and sinapisms were applied to the abdomen and to the feet; the face being colored and the scalp showing many turgid vessels, a large leech was applied to the left temple, and the wound was allowed to bleed for half an hour after the animal fell off. No more convulsions through the day. At 7½ o'clock P. M., mustard was applied to the back of the neck. The night of 21st was passed by the patient in quiet sleep. 22d, very bright and well to all appearance, until 9½ o'clock, A. M., when he had another very severe convulsion, lasting several minutes longer than the two previous ones. He was seen fifteen minutes after the access of the fit; was found stupid, with an occasional wild look of the eyes; had been placed again in the warm bath. Mustard-water frictions to the extremities were continued; the head being rather hot, cold applications were cautiously made to it; one drachm of castor oil was given; discontinued the breast milk. Dr. Storer saw the patient at this time, and recommended calomel and Dover's powder, one eighth of a grain of the former to one half of a grain of the latter, every three hours. A continuance of the mustard water frictions were also advised. Dr. S. believed that another leech might be needed. Dr. James Jackson, who had been sent for at Dr. M.'s request, visited the child shortly after, and gave a favorable prognosis. It was thought best by him to restrict the child's nursing to one minute's time every two hours; and, in the intervals, to allow sugar and water. Dr. J. thought that although another leech might possibly be required, he should 'be slow to apply it.' The remainder of the management was concurred in. The powders above mentioned were commenced, and the other means continued. There seemed a degree of amendment in the afternoon of this day, and there had been some good sleep. The night of the 23d was quietly passed; there was only one dejection; a little colicky pain from flatulence; no convulsive action. 23d, Quite well, seemingly; pulse 118, rather sharp (yesterday, 128 to 130); skin moist; one powder was taken at bedtime last evening, and another this morning. The vesicle of vaccination has broken and partially dried into quite a large scab; it was full, yesterday. In the afternoon of this day the child seemed dull and stupid, possibly from fatigue; the lips and tongue somewhat swollen; suspended the regular use of the powders; renewed the mustard frictions, etc. He was now allowed to draw the breast during three minutes, not having nursed for three hours previously. Flatulence troublesome; relieved by mint-water. 24th—Night quiet; had one dejection; got one powder about midnight; the eyes somewhat red; no signs of returning rubaceous eruption; tongue white; occasional colic. 25th—Nearly as well as ever. 26th—Same record. 27th—A cervical gland, on the left side (that of vaccination), much enlarged; otherwise very well and lively. Discontinued visits. From the last date to the present time, there has been no untoward occurrence, the child seeming better, even, than before his illness.

"The supervention of measles upon vaccination, by the doctrine of chances must be rare; a purely accidental occurrence. The points of interest in this case are the evident mutually retarding influence of the two affections thus coexisting; the modification of the vaccine vesicle and of the eruption of rubella by this action—not uncommonly witnessed under such, or similar, circumstances of complication—and, especially, the convulsions, as to their cause. Dr. M. was at first inclined to ascribe these to the retrocession of the measles; but it will be noted that they were manifested upon the eighth day after vaccination, when the vesicle should be perfect and the primary febrile action is usually observed—and consequently they may be more reasonably referred to the latter. This was Dr. Jackson's opinion. How much influence the conjunction of the two affections may have had, however, can hardly be determined. In his recently-published volume, Dr. Jackson gives an instance where convulsions took place in a child, on the eighth day after vaccination. Some time previous to this, the patient had had pneumonia, which was ushered in by convulsions, and the same had occurred, also, during dentition. Dr. J. had apprehended they might take place after the vaccination, and had forewarned the mother on the subject. He refers to other cases in which convulsions were observed in children at the commencement of bronchitis and scarlatina, but mentions only one after vaccination. In the case detailed above, there had not been any convulsions, previously, nor any threatening of them; there was, therefore, no reason to expect them.

"In this connection, the remark of Sydenham may appropriately be referred to 'that an epileptic fit, in infants, is so sure a sign of small-pox, that if, after teething, they have one, you may predict variola—so much so, that a fit over night will be followed by the eruption next morning. This, however, will be generally mild, and in no wise confluent.' (*Works, Ed. Soc. edit.*, vol. ii., p. 252). Dr. Jackson also remarked 'that he believed convulsions are not rare in children, when the symptoms, so-called of small-pox first appear—corresponding to the eighth day of vaccination.' It would seem that the accident must be infrequent after simple vaccination." (*Boston Med. and Surg. Journ.*, June 19, 1856).

Joler has described an epidemic of measles that took place in the Retzat Circle, in Bavaria, in the district where he himself resided. He says that the disease was much milder among the vaccinated than among the unvaccinated. 15 in 52 died among the non-vaccinated, while barely 1 in 300 died among the vaccinated, showing that measles was 86 times more fatal among the former than the latter.

As far as our knowledge extends there are but few facts bearing upon the question of the possibility of the transmission of the poison of measles along with the vaccine virus.

The experiments of several authors have shown that measles may be transmitted by inoculating a sound person, either with

the blood, with the fluid of the accidental vesicles which sometimes complicate the eruption, or with the secretions of those affected with the disease.

Dr. Home of Edinburgh in 1758, appears to have been the first European physician who proposed and performed the inoculation of measles. His method of inoculation was to apply cotton dipped in the blood of a measly patient to a wound in the arm of the well patient. He describes the febrile symptoms as appearing on the sixth day, and of a mild character with no secondary complications. (Clinical Facts and Experiments 1758). Mr. Wachscl, of the small-pox Hospital, in the early part of this century, inoculated successfully a lad, with fluid taken from the measly vesicles. In 1822, Dr. Speranza, an Italian physician, in the territory of Mantua, repeated the experiments of Dr. Home, Professor of Materia Medica in the University of Edinburgh. He inoculated six cases and afterwards himself, with the blood taken from a slight scratch in a vivid papula. In a few days the measles appeared; and went through their course mildly and regularly. This encouraged him to make further experiments; and he says they were all successful.

Dr. Von Katona of Borsoder, in Hungary, conducted an extensive series of experiments upon the inoculation of measles in 1842. He inoculated 1122 persons, by taking the blood and fluid from the vesicles, or a drop of the tears from a patient laboring with the disease. The operation is said to have been performed in the same manner as the inoculation for small-pox; the infecting blood was drawn from the surface most effloresced. The puncture was immediately surrounded by a red areola, which soon disappeared. On the seventh day, the fever set in with the usual premonitory symptoms of measles, as rigors and catarrhal symptoms; on the ninth or tenth day the eruption appeared; on the fourteenth desquamation commenced with decrease of fever and eruption; and on the 17th day from inoculation (7th or sometimes 8th from eruption), the patients were in general convalescent and apparently well. Dr. Katona failed only in 78 cases, out of 1112 (seven per cent.); and he affirmed that the resulting disorder was mild, contrasting favorably with the sever-

ty of the reigning epidemic. No deaths occurred among the inoculated. The fruitless and unsatisfactory experiments, which have been performed at different periods for the purpose of testing the possibility of inoculating measles, cannot be adduced as evidence against these well established facts; for a single successful inoculation is sufficient to overthrow any number of unsuccessful attempts.

Dr. George Gregory in his valuable *Lectures on the Eruptive Fevers*, even goes so far as to express his belief that the child whose case he had detailed as having undergone cow-pox after measles, "received the germ of measles and of cow-pox at the same time; in other words, that unknown to me the child that furnished the lymph was incubating the measles, with the zuma or poison of which the vaccine matter had become impregnated."

The following is the case as recorded by Dr. Gregory:

Eliza Finch, aged four months, residing at Pentonville, was vaccinated by me at the Small-pox Hospital, May, 15th, 1832. May 17, the child began to droop. Bilious vomiting, very severe, with drowsiness, succeeded. Much blood passed by stool. The head was very hot. Vomiting continued all that and the four following days. It ceased on the 22d. On the 24th the other febrile symptoms yielded a little. On the 25th (nine days from the invasion of symptoms, and eleven from the probable reception of the germ,) measles appeared and went through its course regularly."

Whilst the preceding facts, in the main, support the doctrine of Hunter, and show that where two poisons, representing two distinct contagious exanthematic diseases, act simultaneously upon the human being, the most obvious pathological phenomena excited by the poisons will not occur simultaneously, but in succession, the one poison retarding the action of the other, the one producing its cycle of changes, whilst the other remains dormant as it were, during the action of the other, and immediately after the changes induced by the first cease, inducing its own distinct effects: at the same time it must be admitted, that the character and course of these specific eruptive diseases, are greatly modified

by such altered states of the constitution as exist in scurvy, scrofula, and secondary syphilis.

In that class of diseases represented by constitutional syphilis and scurvy, the whole mass of blood is at fault, and the nutrition is perverted, and the course and products of diseased actions are comparatively modified.

As all the nutritive processes are more or less deranged in scurvy and secondary syphilis, and as it is now established that the blood in the latter disease is capable of reproducing syphilis when inoculated in healthy bodies, and as we have shown that in scurvy the blood is so deteriorated and the forces so depressed, that the smallest injuries tend to degenerate into foul gangrenous ulcers, it is but reasonable to conclude, apart from well-established facts, that the vaccine lymph would partake of the qualities and properties of the blood from which it is formed, and the parts by which it is secreted. And even if the doctrine be maintained that the vaccine matter, as well as all other special morbid poisons, have an unvarying chemical and physical constitution, the difficulty is not removed, as in the practice of vaccination we are unable to separate the active agent of the virus, from much extraneous matter, as lymph and blood. And we contend that it is impossible to open a living vaccine vesicle and draw matter for vaccination, without injuring to a greater or less extent, the delicate blood-vessels, within and around the vesicle.

With reference to the concurrent action of the poisons of two contagious Exanthemata, upon the same system, we know nothing whatever of the state and mode of the existence of that poison which lies dormant whilst the other is acting. Does it remain in the part where it has been inserted, or does it exist as well in the blood, and affect those organs and tissues which are not implicated in the action of the first?

Until the relations and effects of each special exanthematous poison has been carefully studied, and its effects determined upon the constitution of the blood, upon the process of nutrition, upon the action of the nervous system, and upon the chemical

and physical phenomena of the body, as manifested more especially in the disturbances of Circulation, Respiration and Calorification, and Excretion, it will be difficult if not impossible to settle such questions.

SECTION IV.

DRIED VACCINE LYMPH, OR SCABS, IN WHICH DECOMPOSITION HAS BEEN EXCITED BY CARRYING THE MATTER ABOUT THE PERSON FOR A LENGTH OF TIME, AND THUS SUBJECTING IT TO A WARM MOIST ATMOSPHERE.

The effects of such decomposing matter, resemble those of the putrid matter received in dissecting wounds.

The practice of some physicians to mix a considerable portion of powdered vaccine scab, with water upon a glass slide, and to use this in a number of vaccinations, from house to house, is not unattended with danger, especially during warm weather. The danger of this filthy procedure, is three-fold. First, when the dried scab is used, the chances of communicating the vaccine disease by inoculation are lessened, and there is greater danger of communicating other diseases through the medium of this dried mass of pus, blood, lymph and cellular tissue. Second, when animal matter is finely divided and mixed with water, and subjected to a temperature of near summer heat, all the conditions are supplied for those active chemical changes, which in nitrogenized matters, frequently lead to the formation of poisons, capable of exciting rapid and destructive changes in the living organism. Third, in using matter from a common store, fresh blood is frequently conveyed from the patient vaccinated, upon the instrument or lancet, to the vaccine mixture. The liability to putrefactive change is not only increased by this mixture, but also the danger of communicating secondary syphilis, or any other disease capable of being transmitted by vaccination is augmented. When a score, or more, cases are vaccinated from the same supply, and with the same instrument, if the greatest precaution is not employed, more or less blood from different indi-

viduals becomes mixed with the virus. The method so common in America, of vaccinating with the dried scab, should be entirely abandoned.

In the warm climate of the Southern States, it is especially difficult to preserve vaccine matter for any length of time, without more or less change and even putrefaction. The length of time which the vaccine virus will retain its active properties, will depend upon the temperature and the moisture of the climate.

The true mode of preserving and propagating the vaccine virus, is that recommended by Jenner, viz.: the inoculation of the lymph directly from the arm at a period not later than the eighth day. By a succession of such vaccinations upon a number of children, transported for this purpose, Dr. Francis Xavier Balmis, Surgeon-Extraordinary to the King of Spain, imparted vaccination to many nations during his voyage round the world (1803-1806) executed for the sole purpose of carrying to all the possessions of the King of Spain beyond the seas, and to those of other nations, the inestimable gift of vaccine inoculation.

At an early day in the history of vaccination, Dr. Jenner made numerous attempts to send the vaccine virus to the most distant possessions of the English in the East. After the failure of the virus sent by ships to India, he proposed that on board some ship going to India twenty recruits, or men of any description who had not had the small-pox, should be selected; and a surgeon appointed to attend the successive vaccinations. Dr. Jenner thus engaged that the vaccine disease should be carried in its most perfect state to any of the English Settlements. Upon the rejection of this proposition by the government, he formed the plan of equipping and sending out a vessel to India with such arrangements and such a number of men as to ensure the continuous transmission of the vaccine virus, by private subscriptions, and put down his own name, for one thousand guineas. Before his design could be carried into execution, tidings arrived from the east, that Dr. De Carro had succeeded in forwarding vaccine matter from Vienna to Constantinople, and from thence to Bombay. The manner in which Dr. De Carro, (by whose unwearied labors the vaccine disease was first disseminated over Germany, Venice,

Lombardy and other parts of Europe,) transmitted the vaccine virus to India, possesses great interest at the present time, when so much carelessness is manifested by the profession both in the selection and in the preservation of the virus. Many disappointments having arisen from the difficulty of transmitting it in an active state, to distant countries, Dr. De Carro employed every expedient that ingenuity or experience could suggest to obviate them. Various methods had been tried. Impregnated lint, or threads enclosed between plates, or in bottles and in tubes closed up with wax. The practice of imbuing the points of common steel lancets was soon abandoned. To these succeeded lancets of silver, silver gilt, gold and ivory. After a series of trials, Dr. De Carro, gave the preference to ivory, which he considered to be, in all respects, the most secure vehicle for transporting the virus. On lancets of this material it was sent from Breslau to Moscow, where, under the patronage and actual inspection of the Russian Empress, it completely succeeded. As that which was destined for Bagdad would be exposed to the accidents of a long journey, in a climate heated by a scorching sun, he took special care to protect it as much as possible from external influence. He sent some on lancets of silver, silver-gilt, and ivory: he also impregnated some English lint with the vaccine fluid, and enclosed it between glasses; and when he had properly secured them he dipped them at a wax-chandler's till they formed a solid ball, which he enclosed in a box filled with shreds of paper. In this state the packet was safely conveyed across the Bosphorus, and passed over the whole line of deserts; and he had the satisfaction of hearing that, on its arrival on the banks of the Tigris, its contents were still liquid, and succeeded on the first trial. It was received on the 31st of March, 1802, upon the banks of the Tigris, and before the end of June it had reached Bombay.

Dr. De Carro, in a letter to Dr. Jenner, dated Vienna, April 22d, 1803, thus describes the method which he had employed for the preservation of the vaccine virus:

"I do not know whether you are well informed of the great improvement which M. M. Ballhorn and Stromeyer have made to the glasses invented by you. They have taught us a simple and easy manner to preserve the vaccine lymph fluid during

an indefinite term. The Hanoverian Vaccinators take a small bit of English *charpie*, which you call, I believe, *dry lint*. The quantity must be, of course, equal to the concavity of the glass. The pustule then is punctured by a circular or half-circular incision with the lancet, so as to open a greater number of the cells forming the vaccine pustule covered with the same pellicle. The lint is applied upon the pustule on the most woolly side, so as to act better as a syphon. It pumps in a very short time a sufficient quantity of vaccine fluid to saturate it as completely as if it had been dipped in a glass of water, particularly if the lint is now and then gently pressed with the point or back of the lancet. When it is quite full you take it with the lancet, and place it carefully in the cavity of the glasses; you put a drop of oil, or a little maulage upon the internal surface of the glasses; you make the flat bit of glass slide upon the *charpie*, so as to exclude the air as much as possible; you tie the two bits with thread, and seal the edges. To prevent the access of light, I commonly fold it in a black paper, and when I was desired to send it to Bagdad, I took the precaution of going to a wax-chandler's, and surrounded the sealed-up glasses with so much wax as to make balls. With this careful manner, it arrived still *fluid* on the banks of the Tigris." *Life of Edward Jenner*, vol. I, pp. 429, 430.

The method so extensively employed in America, of preserving the entire scab after it separates from the arm, by enclosing it in wax, is not only less reliable than the method practiced by Drs. Jenner and De Carro and others, but it is attended with greater danger, from the changes induced by heat and moisture.

Shortly after the introduction of vaccinatin into the United States, by Dr. Waterhouse, ignorant persons, in New England, not of the Medical Profession, who were stimulated by avarice to carry on a traffic in vaccine matter, obtained the shirt-sleeves of patients which had been stiffened by the purulent discharge from an ulcer consequent on vaccination. These they cut into strips, and sold about the country as impregnated with the true vaccine virus. Several hundred persons are said to have been inoculated with this poison, which in some cases produced great constitutional disturbance.

SECTION V.

THE MINGLING OF THE VACCINE VIRUS WITH THAT OF THE SMALL-POX; MATTER TAKEN FROM THOSE WHO WERE VACCINATED WHILE THEY WERE LABORING UNDER THE ACTION OF THE POISON OF SMALL-POX, WAS CAPABLE OF PRODUCING A MODIFIED VARIOLA, AND COMPARATIVELY MILD DISEASE IN

THE INOCULATED, AND WAS CAPABLE OF COMMUNICATING BY EFFLUVIA SMALL-POX IN ITS WORST CHARACTER TO THE UNPROTECTED.

In more than one instance small-pox was disseminated, by vaccination with what was considered as vaccine virus. In all such cases the virus was obtained from patients who were laboring under the action of the poison of small-pox, at the time of the insertion of the vaccine matter. Some cases of small-pox were said to have originated from the employment of small-pox scabs, which had been sent through the lines by the enemy as good genuine vaccine matter. As far as my knowledge extends, such accidents did not arise from the wilful and malicious dissemination of small-pox matter, as was charged publicly through the newspapers; but they were referable to the careless employment of vaccine matter derived from patients in small-pox hospitals, or from members of households vaccinated after small-pox had appeared in their midst, and consequently after the introduction of the poison into their systems.

Such accidents are by no means new to the profession, for more than half a century ago, they had well nigh proved fatal to the infant cause of vaccination. Many of the patients experimented upon, by Dr. Woodville at the small-pox hospital in London, were not only exposed to a variolous atmosphere, but they actually had small-pox matter inserted into their arms on the third and fifth days after vaccination. Dr. Jenner had positively asserted that pustules do not belong to the cow-pox: Dr. Woodville, on the contrary, affirmed that three-fifths of the patients whom he had inoculated with vaccine matter, had pustules not to be distinguished from variolous ones. Dr. Woodville, in an interview which he held with Dr. Jenner on the 23d of March, 1799, mentioned that the cow-pox had been communicated by effluvia, and that the patient had it in the *confluent way*. Dr. Jenner is said to have remarked on this marvellous occurrence, "Might not the disease have been the confluent small-pox communicated by Dr. Woodville, as *he* is always full of the infection?"

Such careless experiments as those of Dr. Woodville, conducted in a *small-pox hospital*! excited the strongest feelings of disappointment among the principal medical men of London, and for a season threw doubt upon the accuracy of Dr. Jenner's statement. And it was only after careful investigation that Dr. Jenner was able to demonstrate that the *London cow-pox* was somehow or other compounded with *small-pox*.

This contaminated matter, from the London small-pox hospital, was distributed to different parts of the country by Dr. Pearson, and caused most unpleasant accidents. Some of this contaminated matter fell into the hands of Mr. André, Surgeon at Petworth, and fourteen persons who were inoculated with it had variolous eruptions and in some cases suffered severely. Lord Egremont wrote a long letter on this occasion to Dr. Jenner, detailing the occurrence at Petworth. The reply of Dr. Jenner to this letter is worthy of careful consideration, in the light which it throws upon similar accidents occurring during the recent war.

DR. JENNER TO LORD EGREMONT.

My Lord:—I am extremely obliged to your Lordship for your kindness in giving me so fully the account of the late inoculation at Petworth; a subject which, before, I did not clearly understand; and which, of course, had given me much vexation. I will just briefly lay before you part of the history of the cow-pox inoculation since my experiments were first publicly made known; which may tend in some measure to explain in what manner pustules may be produced.

About a twelve-month ago Dr. Woodville, Physician to the small-pox hospital, procured some virus from a cow at one of the London Milk-farms, and inoculated with it several patients at the small-pox hospital. Fearful that the infection was not advancing properly in some of their arms, he inoculated them (some on the 5th, others on the 5th day afterwards), with small-pox matter. Both inoculations took effect; and thus, in my opinion, a foundation was laid for much subsequent error and confusion; for the virus thus generated became the source of future inoculations, not only in the hospital, but in London, and many parts of the country.

Hearing a murmur among medical people that the cow-pox was not the simple disease I had described, but that in many instances it produced as many eruptions as I was attended with as much severity as the small-pox, I went to town with the view of inquiring into the cause of this deviation. Dr. Woodville at once invited me to the small-pox hospital, and very ingeniously told me the whole of his proceedings. The inoculated patients were shown to me, and though some were without eruptions and exhibited the appearance of the true cow-pox, others were very full of them, and I could not discern any difference between them and the perfect small-pox. I therefore did not hesitate to tell the Doctor that it clearly appeared to

me that the small-pox had crept into the constitution with the cow-pox; that I did not consider them as two distinct diseases, but as varieties only of the same disease; and therefore they might co-exist in the same constitution, and that thus a mixed disease had been produced. I communicated also the same sentiment to Dr. Pearson, who was then, and had been, busily employed not only in inoculating from this source, but in dispensing threads embued in the virus to various places in our own country, and to many parts of the continent. Foreseeing what was likely to ensue from these hasty measures, I remonstrated against them, but was not listened to. In many places where the threads were sent a disease like a mild small-pox frequently appeared; yet, curious to relate, the matter, after it had been used six or seven months, gave up the variolous character entirely, and assumed the vaccine; the pustules declined more and more, and at length became extinct. I made some experiments myself with this matter, and saw a few pustules on my first patients; but in my subsequent inoculations there were none. From what I once saw at the hospital, I had reason to think that some of these threads sent out were not only stained with small-pox matter from the contamination spoken of, but that they had sometimes a dip in a real small-pox arm; as the patients were all mingled together at the hospital, and stood with their arms bare, ready to afford matter one among another. Without making any further trials with matter from the cow managed in another way, Dr. W. published a volume containing the result of his practice, which certainly damped the spirits of many who had from my representation taken up a high opinion of the cow-pox inoculation. A thought now struck me that, if possible, it would be proper to procure matter from a London cow, and compare its effects with that generated in the country.

Unwilling to determine in a hurry, I procured matter from a London cow, conceiving it possible that the animal in this situation might generate matter possessing qualities differing in some measure from that which is more in a state of nature in our meadows here; but the result convinced me that the virus was the same, as 500 people were inoculated from this source without the appearance of any pustules. But this history, my Lord, does not tell you by what means the pustules appeared at Petworth; but it informs you how errors may arise, and how they may be prevented. There is another source which I fear will be too common. Lancets are often carried in the pocket of a surgeon with small-pox dried upon them, for the purpose of inoculation. A gentleman some time ago sent a lancet here to have it charged, as it is called, with cow-pox matter; perceiving it stained at the point with some dried fluid, it was sent back; when he immediately recollected that his lancet was prepared with the matter of the small-pox. What confusion might have happened from this; and how narrowly we escaped it! For it was but an equal chance probably, that, had the lancet been used, a direct small-pox might have been produced; for the chances were equal whether it produced one disease or the other.

It may be necessary to observe, it is improbable that a mixture of the two matters used in this way would have produced a mixed disease, as two different diseased actions cannot go forward in one and the same part at the same time, so that the disease would have been either the perfect cow-pox or the perfect small-pox.

The matter which was made use of, I hear, came from Dr. Pearson; and doubtless Mr. Keate will have candor, and, I hope, industry enough to trace the error to its source. That there was error somewhere, of which Mr. Keate became the inno-

cent cause, is a fact that I think will not admit of controversy. I have sometimes seen, perhaps in one case in a hundred, a few scattered pimples about the body and sometimes rashes: but these have arisen from the inflammation and irritation of the arm, for it is very well known that many acrid substances applied to the skin, so as to produce local inflammation, will frequently occasion a similar appearance."

This letter, in which Dr. Jenner announces the doctrine held and taught by his friend John Hunter, (viz., two diseased actions, cannot go forward in one and the same part, at the same time), is important not only in the demonstration which it affords of the transmission of both small-pox and cow-pox, at the same time, through the same mass of matter, but it also contains a strong argument for the view held by Jenner that these were not distinct diseases, but only *varieties* of the same disease.

Dr. Adams, in his work on Morbid Poisons, gives the following interesting and important observations, which confirm the correctness of the views of Dr. Jenner.

"It is to be hoped that a very correct attention to the processes of variolation and vaccination will enable us to ascertain the exact analogy which exists between two morbid poisons evidently distinct, yet not entirely separated by those laws which we have traced in others. The correspondence in the laws of each—the peculiarities in which they differ—the manner in which they interrupt each other's action, and the manner in which they may be made to act in concert, are all equally interesting, and are the daily subjects of experiment and observation. At present the following may be considered as established facts:

"Each, when inserted, requires about the same time to produce its local effects.
"A subject, that has regularly passed through either, is insensible to the future constitutional effects of the variolous poison.

"Each will produce secondary eruptions, having the same property of infecting as the primary; but the secondary eruptions appear more than ninety-nine times in a hundred in small-pox, and not once in three hundred, if the skin is otherwise entire in the cow-pox.

"In the small-pox, secondary pustules appear whilst the primary is advancing, and mature two or three days after them. In cow-pox, when secondary vesicles appear, it is not till the primary has begun to scab.

"The small-pox may infect by the effluvia, the cow-pox can only be communicated by the secretion from the local infection.

"When these poisons are inserted at the same time in the same part of the same subject, by mixing the secretion of each, only one will produce its effect.

"When inserted separately in different parts of the same subject, each will produce its local effect, and at the same time.

"If cow-pox is inserted at the same time that the subject is exposed to a vitiated atmosphere, the former will supersede the effects of the latter. If inserted four days

later, the effect will be less certain, but as far as can be ascertained, not more uncertain than from the variolous insertion." (Adams on Morbid Poisons, p. 10-16.) Dr. Adams gives several instances to show that the vaccine and variolous diseases may be confounded in certain cases, that is, that the laws peculiar to one may occasionally influence the other. (See pp. 16-20.)

"The invaluable Jennerian discovery has introduced us to a morbid poison, the properties of which are different from all others that we are acquainted with in superseding the constitutional susceptibility to another. As such a law as this is unknown in any other two morbid poisons, we might suspect the analogy between these two would be clearer than between any other two. We might even expect that the characters of the two might be altered by applying both at the same time, and also that the phenomena of one might imitate the phenomena of the other in such a manner, as to render the distinction between the two often doubtful. It is therefore, rather a matter of surprise that the distinction should be so regularly preserved, and the laws which separate other morbid poisons so rarely infringed.

"The next thing I would remark, is that small-pox and cow-pox, contrary to the law of all morbid poisons, which are different in their action, will proceed together in the same person, without the smallest interruption of each other's course. If inserted nearly at the same time, in the same person, each proceeds in the same course as if it were in two different subjects: if inserted nearly in the same spot, the two form one common areola, but the vesications are distinct, and each preserves its own character, till that of small-pox becomes purulent from suppuration for the separation of the slough. If secondary pustules follow from the small-pox, and they should continue coming out till the cow-pox has completed its progress, its vesicle, like any other inflamed part, will become the seat of a small-pox pustule, or the whole vesicle will become purulent, contrary to its legitimate character. In the first case, you may take small-pox matter from the pustule, which, by the adhesive inflammation, will remain distinct from, though seated in part of the vaccine vesicle; and from the other parts of the vesicle you may take the vaccine matter, and each will perpetuate its respective morbid poison. If the whole vesicle becomes purulent, it is a variolous pustule, and will inoculate small-pox.

"It was remarked by Dr. Woodville, that if a person is inoculated with small-pox to-day, and three or four days after is re-inoculated with the same morbid poison, though the last insertion may remain a smaller pustule than the first, yet both inoculations will arrive at their height at the same time. The same takes place in cow-pox; and also, if a person is inoculated to-day with cow-pox, and three or four days after with small-pox, or to-day with small-pox, and three or four days after with cow-pox, the two insertions, though the last may remain smaller than the first, will mature and scab at the same time.

"By these facts it appears, first, that a marked kind of small-pox may be perpetuated. If, therefore, the cow-pox is a marked kind of small-pox, there can be no reason why it should not have been perpetuated with its true character; and that the cow-pox is such, appears, secondly, by its not being interrupted by, and not interrupting the progress of small-pox, and by both retaining their respective laws and characters at the same time, whether inoculated separately in different subjects, or the same; or if each has been inoculated in the same subject at different times, the consequence is similar to the inoculation of either one, at different times.

"These experiments have been repeated so often, as to leave no question concerning the law. The same experiments have been repeatedly tried with small-pox and measles, and also with cow-pox and each of the others, yet these interruptions have always followed, which have been remarked in the early part of the work.

"As therefore, a marked variety of small-pox is capable of preserving its distinct character under inoculation, there seems no reason why the cow-pox should not be among such varieties; and as any of the known varieties will destroy the susceptibility to the disease in all other forms, so there is no reason why cow-pox, if among the varieties, should not do the same; and there is the more reason to expect this, because, contrary to any other morbid poisons, the action of small-pox and cow-pox are maintained at the same time in different parts of the same constitution, subject respectively to similar laws, whether only one or both of them are applied in any variety of forms.

"It may be said that small-pox is an eruptive disease, whilst cow-pox, though affecting the constitution, is only confined in its local action to a single part. But small-pox is sometimes, we have seen, equally confined in its local action, and principally in those cases in which its appearance most resembles cow-pox. It is not less certain that cow-pox, on some occasions, produces secondary eruptions. Besides the cases I have seen myself, the Rev. Mr. Holt (Med. and Phys. Journal) gives an account of full eruption of vesicles, which had the same properties of contagion as the inoculated part. The Rev. Mr. Ferns saw a few scattered in different parts." (Adams on Morbid poisons, pp. 398-401.)

Dr. Willan found "that when a person was inoculated with vaccine and variolous matter about the same time, (that is, not exceeding a week,) both inoculations proved effective, for the vaccine vesicle proceeded to its acme in its usual number of days, and the maturation of the variolous pustule was attended by a variolous eruption on the skin." (On Vaccine Inoculation, p. 1.)

When cow-pox is inserted during the incubative stage of the casual small-pox, while the small-pox is still latent, the vaccine vesicle for the most part does not advance, or advances tardily and imperfectly. There are exceptions, however, to this rule, and cow-pox and casual small-pox may sometimes be seen running their full course at the same time. In no case, however, does the cow-pox so inserted alter or modify the course of the small-pox. When the variolous and vaccine fluids are inserted into the arms on the same day, each disease occasionally proceeds, preserving its original character. At other times, however, they mutually restrain and modify each other. The vaccine vesicle is smaller than usual, and irregular in its progress, while the variolous pustules which follow are of the kind de-

nominated *variole verrucosae*, vulgarly swine-pock, stone-pock, or horn-pock (Willan on Vaccine Inoculation, p. 5); that is to say they are hard and shining, surrounded with little inflammation, and they suppurate imperfectly. The small quantity of matter they contain is absorbed, leaving the cuticle horny and elevated for many days afterwards. Upon the extremities the eruption does not pustulate at all, but is minute and papulous, and terminates by desquamation. It will be found in most cases that even though the eruption be modified in its character, there is nevertheless considerable disturbance of the general system under the joint influence of the variolous and vaccine poisons.

Dr. Woodville has said that if the cow-pox matter and the small-pox matter be both inserted in the same arm of a patient, even within an inch of each other, so that on the ninth day the same efflorescence becomes common to both the local affections, nevertheless inoculating from the cow-pox tumor the genuine vaccine disease will be produced (*Observations on the Cow-pox*, p. 12); but if the inoculation be performed with a mixture of the two matters, then the chance is equal that small-pox or cow-pox will be the result, or the varioloid disease.

When the insertion of the vaccine lymph precedes that of the variolous by a period not exceeding four days, both diseases advance locally. Sometimes an eruption of small-pox papule follows. At other times the variolous fever is slight and unaccompanied by eruption. Under these circumstances, matter taken from the primary vesicles shall sometimes communicate cow-pox and small-pox respectively, but more commonly the variolous poison predominates, and contaminates the lymph of the vaccine vesicle. It was ignorance of this phenomenon, in the mutual action of the vaccine and variolous poisons, which occasioned Dr. Woodville's mistakes at the small-pox hospital in 1799.

Variolous matter inserted into the arm at any period not exceeding a week from the date of vaccination will take effect and be followed by a pustule. After that time no effect is produced.

When small-pox inoculation precedes by three or four days the insertion of vaccine lymph, the vaccination advances, but after

the tenth day the fluid in the vaccine vesicle becomes purulent; and in that state will communicate small-pox. (Willan on Vaccine Inoculation, p. 8; also Dr. George Gregorie's valuable article on Vaccination in the *Cyclopaedia of Practical Medicine*.)

Dr. Denby, whilst admitting that the period of incubation of variola may be somewhat undefined, as in the case of other animal poisons, concludes that nevertheless, from experiments, a fair conclusion may be formed as to the usual period of this incubation, when vaccine prophylaxis may be induced. And from these Dr. Denby judged that, if on the third day, before the onset of erethism, rigor, and headache, perfect lymph be inserted, prophylaxis is almost certain, assuming three or four days for the premonitory symptoms before the variolous point or papula appears. The vaccine vesicle will then be eight or nine days old, the areola will be becoming indurated, and erethism will exist. Dr. Denby considers that in this fever against fever, the essence of prophylaxis really exists. If under this influence the variolous papula proceeds, it will resemble umbilicated variella or horn-pock. If the vaccine be used two days later, especially if there be bronchial or pulmonary symptoms present, it will be useless. The papula may be just apparent, but it will be blighted. There are of course exceptions to this rule. A woman was delivered, says Dr. Hennen, while suffering from confluent variola; the infant was vaccinated a few hours after birth. The mother died on the 11th day; the infant had true vaccine, and lived. (*Med. Times*, Oct. 25, 1851). In an analogous case reported by Mr. T. C. Beatty of Durham, the child delivered from a mother in whom the variolous pustules made their appearance during labor, was not vaccinated until the morning of the fourth day after its birth. True vaccine was the result; and yet, on the eighth day after she was vaccinated, when the vesicles were fully matured, the little patient was very ill, and showed signs of an eruption under the skin, which proved to be confluent small-pox, of which the little creature died four days after. (*London Lancet*, 1852.)

Dr. Robert Fowler of the Loughborough Dispensary, and Mr. Robert Tod of Gilmore Place, Edinburgh, (*London Lancet*, 1852); M. M. Herard and Bousquet, (*L'Union Médicale*, Nos.

108, 109, 110, *Bulletin de Thérapeutique*, tom. xxxv., pp. 342-52), and others, have recorded cases proving the possibility of the simultaneous existence of small-pox and the vaccine disease, and confirming the correctness of the conclusions of Jenner and the older observers.

M. Bousquet goes so far as to deny that the two eruptions, variola and vaccinia, exert any reciprocal reaction, and the nearer they appear together, the more independent are they of each other. Suppose, for example, that they could appear at the same hour, then each would pursue its ordinary course, just as if the other were not present. But supposing the one eruption appears after the other, all will depend upon the space of time separating them. If this be only some hours, or even two or three days, all passes on as just stated. The case is different when one of these eruptions is greatly in advance of the other. If this is not to such an extent as to exclude, the eruptions progress together, but not in parallel. The most advanced always keeps its advantage, and finishes at its ordinary epoch, without having undergone any change in form or duration. The other follows it at a distance, but after the variolous capacity of the subject has become exhausted by the first, the second dies away. In these influences, M. Bousquet considers that there is nothing direct, active or special, they are the consequences of the faculty possessed by the eruptions of supplying or substituting each other. The vaccinia does not arrest the variola, but it is the variola that stops short in the face of the vaccinia; and, conversely, variola does not cut short the course of vaccinia, but this last interrupts its own course in presence of the variola. It is the right of precedence, and the more widely the two eruptions are separated, the more readily do they exclude each other, while the nearer they are together, the more independently do they proceed. Considered in themselves, the vaccine and variolous virus are so little capable of destroying each other's energy, that if they are mixed together, and inoculation performed with the mixture, M. Bousquet affirms that two perfectly distinct eruptions may be produced. Considered as regards their effects,

therefore, according to this view, it cannot be said that vaccinia cures variola, or even, rigorously speaking, that it prevents it. It takes its place, stands in its stead, and is neither more nor less than a substitution. Thus, so far from explaining the operation of vaccinia by the supposed opposition it offers to variola, we would rather do so by the analogy and reciprocal action of the two diseases. (Bulletin de Théraputique, tom. xxxv., pp. 342-52; also The British and Foreign Medico-Chirurgical Review, April, 1849.)

From the facts recorded in this section, we deduce the practical conclusions:

First—That vaccine matter derived from the patients of small-pox hospitals, or from those in civil or military practice who have been exposed to the contagion of small-pox, should never be used for the propagation of the vaccine disease.

Second—The vaccine disease is not a distinct disease from small-pox, but a variety or modified form of the variolous affection.

SECTION VI.

DRIED VACCINE LYMPH OR SCABS, FROM PATIENTS WHO HAD SUFFERED WITH ERYSIPELAS DURING THE PROGRESS OF THE VACCINE DISEASE, OR WHOSE SYSTEMS WERE IN A DEPRESSED STATE FROM IMPROPER DIET, BAD VENTILATION, AND THE EXHALATIONS FROM TYPHOID FEVER, ERYSIPELAS, HOSPITAL GANGRENE, PYÆMIA, AND OFFENSIVE SUPPURATING WOUNDS.

In several instances during the revolution death resulted from PHLEGMONOUS ERYSIPELAS, following vaccination in apparently healthy patients, in both civil and military practice.

It was believed that in some cases the poison of ERYSIPELAS was conveyed along with the vaccine virus.

In one instance which came to my knowledge, the lives of several negro women and children were destroyed by Erysipelas excited by vaccine matter taken from the same scab, and a stout

healthy white man who was vaccinated with the same matter, and by the same physician who vaccinated the negroes (on a neighboring plantation,) was extremely ill from the effects of the poisonous matter, and barely escaped with the loss of a large portion of the muscles of the arm.

I was informed upon good authority that this matter caused the death of a pregnant negro woman, and of another negro and her young infant, of some week or ten days of age, at the time of the inoculation of the vaccine virus.

The following observations relating to Erysipelas following vaccination, were placed in my hands, by Dr. Frank A. Ramsay, of Memphis, Tennessee:

Communicability of Syphilis by Vaccination. By WM. GRADNER, M. D., of Green County, Tennessee.

I notice in the "Medical and Surgical Monthly—June, 1866," an article taken from the Richmond Medical Journal, June, 1866, by Wm. Fuqua, M. D. Appomattox county, Virginia, on the Communicability of Syphilis by Vaccination.

About the same time referred to by Dr. Fuqua, I had numerous cases of vaccination, in the district of my practice, presenting abnormal features. The people believed it to result from Syphilis, and called the exhibitions by that name. I made close scrutiny of the cases, occurring under my observation, and concluded that they were not syphilitic in origin or manifestation. I regarded them as Erysipelas, presenting the form called Phlegmonous: for which opinion I thought I had reasons. Many cases assumed the form of common Erysipelas, invading limited portions of the arm; and in some few cases the whole surface of the vaccinated limb was affected.

The proper distinction for the practical physician of Erysipelas, is Superficial and Deep Seated—ordinary or common Erysipelas affecting the cuticle proper—deep seated or phlegmonous Erysipelas involving the tissues, particularly the cellular. At present the cause of the difference is inexplicable—why in one case serum, and in the other lymph is poured out, remains a question, while the fact exists. Each distinct inflammation has its habits.

As far as my knowledge extends, the records of medicine do not afford any very large collection of cases of Erysipelas supervening upon vaccination. The following are the most important cases of the apparent excitation of Erysipelas by vaccination, which were noted in the works and journals consulted during these researches:

Diffuse Cellular Inflammation, following Vaccination.—The first was that of a female child, aged five years, who had been vaccinated by a respectable practitioner in Dublin. This child was brought to the physician who reports these cases, about three weeks after it had been inoculated. The arm was then greatly swollen, the swelling extending to the hand; the integuments of the upper arm were of a dusky leaden hue, and a large black slough occupied the situation of the usual crust of the vaccine vesicle. The child's pulse was weak and slow, not exceeding 64. The extremities were cold, tongue dry and coated. There were extensive sloughing and hemorrhage from the mucous membrane of the mouth. The integuments of the cheeks adjoining the commissure of the lips were of a livid hue. The respiration was very much hurried, but no physical sign of disease could be detected in the chest.

The child's parents stated that these formidable symptoms first presented themselves, between the ninth and twelfth day from that on which it had been vaccinated. The practitioner who inoculated the child affirmed that up to that period, the vaccine vesicle ran a healthy course, and that he had vaccinated other children with the same lymph in whom the course of the vesicle was perfectly regular. This child was of a delicate constitution, having suffered with attacks of scrofulous epithelium, pneumonia, and bronchitis. Its health was said to be good, at the time it was inoculated. Complete recovery, though very slow, was effected in this case by the use of mild tonics and stimulants.

The second case was that of a male child, aged eighteen months, who was also vaccinated by a physician of Dublin. About the twelfth day from the period on which it was vaccinated, the arm was attacked with severe inflammation of the erysipelous character, the vaccine vesicle having, up to that day, according to the statements of the parents, run a regular course. On the sixteenth day, a dark slough, as large as a shilling, occupied the situation of the vesicle; the entire extremity was immensely swollen; the integuments of the upper arm were of erysipelous redness, and such of them as were in the immediate neighborhood of the slough were quite livid. The attending fever was of the inflammatory type, the skin being hot, tongue furred, pulse rapid and full, and the thirst great. Until the fever was subdued by cooling and alterative medicines, and the local inflammation relieved by the application of poultices and fomentations, the sloughing spread with the most alarming rapidity. After the sloughs had separated, and the progress of the gangrene arrested, a large and deep ulcer remained with undermined edges, at the bottom of which the muscles of the arm could be distinctly observed; so extensive was this ulcer, that it was not healed for three months, though the case progressed most favorably in every respect."—*Dublin Journal of Medical Sciences*, 1844.

Dr. Greene reported to the Boston Society for Medical Improvement, a fatal case of erysipelas, following re-vaccination, which occurred in January, 1846.

The patient, a gentleman sixty-four years of age, had been vaccinated twenty years before, and re-vaccinated, though without success, two or three times since. On Friday, the day after the re-vaccination by Dr. Greene, he was seized with chills,

nausea, and a sense of general uneasiness; and, at the same time, inflammation commenced in the arm, attended with heat, redness, and pain. He slept none on the following night, and on the next night was attacked with vomiting and purging. The symptoms from this time did not become materially worse, however, till the following Wednesday, when he complained of pain just below the elbow; and on Thursday, a small patch of erysipelas was discovered at this point, which gradually extended over the arm and chest of the affected side, the infiltration of the cellular tissue, keeping about two inches ahead of the redness. He died at ten on Friday evening, a little more than eight days from the time of re-vaccination, the erysipelas having extended to within two inches of the sternum. In regard to the quality of the matter introduced, Dr. Greene remarked that it was taken on the eighth day from a perfectly formed vesicle, on the arm of a perfectly healthy infant, born of healthy parents; that one of his own children had been vaccinated with the same matter, and also another person, in both which cases, the symptoms and appearances were slight.

It is said that in 1849 and 1850, Erysipelas so frequently followed vaccination in Boston, and the result was so often fatal, that many physicians refused to vaccinate, except when it was absolutely necessary, and almost entirely abandoned re-vaccination. Cases were reported to the Boston Society for Medical Improvement, by Drs. J. B. S. Jackson, Cabot, Bigelow, Homans, Putnam, and Channing. From the transactions of this society we select the following cases:

Case Reported by Dr. Cabot.—This being a case rather of diffuse cellular inflammation than common erysipelas. The patient was a gentleman, sixty-nine years of age, who having been exposed to varioloid, was re-vaccinated in two places on the 3d of April. On the second day, two vesicles had formed about the size of a small pin's head, and there was pain in the axilla, with pain and soreness under the pectoral muscles. In about two weeks the inflammation had extended to the hand, and in the course of the third week an opening was made about the elbow, from which a considerable quantity of sero-purulent fluid was discharged; the back of the hand being opened down to the fascia a few days afterwards. From the shoulder the erysipelas extended over the whole back, down the right arm to the elbow, and somewhat over the abdomen from each side; also across the front of the chest, nearly to the right shoulder. The whole duration of the erysipelas in an active form was about seven or eight weeks; neither the hand nor lower extremities were affected; the areola about the vaccine points subsided, but subsequently this surface was attacked with the disease. The suppuration about the left shoulder and down the upper extremity, had been very extensive; the pectoral muscle was separated from the parietes of the chest, and the skin of the forearm was so detached from the subjacent parts that fluids thrown in at the elbow would pass out at the back of the hand; very numerous openings have been made about the elbow and shoulder for the discharge of pus. For about two months the patient was confined to his bed,

and convalescence was tedious. The prostration was not so great as would have been expected in such a case; the pulse not rising above ninety during the active stage of the inflammation; there was, however, some delirium, with chills, headache and pain in the back. No suppuration occurred, except in the parts above alluded to.

Case Reported by Dr. J. Bigelow.—This patient was a gentleman, about thirty years of age, and having been exposed to the small pox, was re-vaccinated with several others, from the same virus. Two days afterwards, an erysipelatous spot, of the size of a dollar, was discovered around the point of vaccination. This spread rapidly in every direction, and at the end of five days, had occupied the whole arm from the shoulder to the elbow. At this time, several dark spots appeared upon the inside of the arm, which in two days were perfectly gangrenous, so that an incision was made five inches in length, without pain. The slough was apparently confined to the skin and cellular substance, inasmuch as the muscular power was at no time lost. Meanwhile the pulse was quick, and the skin hot, with prostration, headache and delirium. In another week, the erysipelas had extended to the whole trunk, half way down the thigh, and to the wrist of the affected arm; the patient being much of the time delirious, or somnolent, and with a pulse of 120. During the third week, the symptoms were greatly aggravated, and the cerebral affection increased; there was also a retention of urine, and the catheter was required for a fortnight. During this time, however, the slough gradually separated, leaving a large, deep ulcer. The patient became convalescent at the end of a month, and slowly recovered; the ulcer requiring another month or more to cicatrize. No other person, who was vaccinated with the same virus, had any unusual symptoms; but a lady of the family, about seven weeks after the vaccination, was attacked with inflammation of the fauces and tonsils, followed by prostration and delirium, and died in a week; during her sickness a livid spot, about two inches in diameter, appeared over the upper part of the sternum, but this disappeared before death.

In another case reported by Dr. Bigelow; a healthy child about five months old, was vaccinated, and the vesicle went on well until the ninth day, when the arm became erysipelatous, the inflammation rapidly spreading over the whole trunk; and the child died in a few days. On the eighth day of the vesicle, the day before the appearance of the erysipelas, matter was taken with which three others were vaccinated, and these patients had perfect vesicles without any anomalous symptoms.

Case Reported by Dr. Hosmer.—The patient was a healthy infant, about three weeks old. On the eighth day, the vesicle appeared well, and matter was taken with which other children were vaccinated, the result being in every case successful. On the tenth day, erysipelas appeared below the elbow, and extended into the axilla; the swelling and redness were very defined, and the inflammation spread rather more rapidly than is usual in the adult. Vomiting and diarrhoea came on, and lasted for some days; and the pulse was too quick to be counted. The head and abdomen then became affected, and on the ninth day from the invasion of the disease, the scrotum and penis were greatly swollen; these last were punctured with much relief, but a deep sloughing of the scrotum took place, one and a half inches in diameter, and nearly exposing the testicles. The extremities were next affected,

but in the mean time the child began to improve, and the pulse had fallen to 120. On the subsidence of the disease, abscesses formed upon the body and limbs beneath the surface, and about the left hip, one that was quite large and deep. This last, is the only one that remains open, and the child is fairly convalescent, after a sickness of about three months.

Dr. Channing mentioned a case of Erysipelas, after vaccination, in which the shoulder, axilla, and pectoral muscles were involved.—(The American Journal of the Medical Sciences, Oct., 1850—pp. 318-321.)

Dr. Charles E. Buckingham, Physician to the Boston House of Industry, has also published an interesting case of "Constitutional Irritation following Vaccination," from which we make the following abstract:

B—, a farmer, twenty-five years of age, of previous robust health, vaccinated on Thursday, August 29th, 1849.

Sept. 1st, he took an emetic, and on the 2d a cathartic dose. Both operated freely. Dr. Buckingham was first called to him at 9 P. M., September 3d. At this time the patient presented the following condition:—Complete anorexia; great thirst; headache; sleeplessness; pain in back; eyes and hearing normal; urine free; pulse 120, full and strong; decubitus dorsal. His late vaccination was not known at this time. Got a saline mixture, consisting principally of bicarbonate of soda and chlorate of potassa.

4th. Febrile action less; has pain in calf of right leg; no tenderness, redness, swelling, or heat.

9th. Pulse 84; appetite good. No sleep last night on account of the pain in the calf, and in the sole of the right foot; has had a sinapism to the foot, with partial relief; no dejections for twenty-four hours; whole of right calf swollen; a circumscribed red spot one and a half inches below head of right fibula, covering about two square inches.

10th. Patient was seen, in consultation, by Dr. H. G. Clark. Redness more diffused; leg much swollen, and oedematous from knee to heel; pain confined to the spot of yesterday, which is, for the first time, tender; no headache or thirst; eyes and hearing normal; neither delirium nor sighing; no appetite; tongue red at its tip, and in other parts covered with a thick creamy paste; pharynx the same; pulse 88, full.

11th, 9 A. M. Pulse 100, full and soft; no dejection. Attention was called to a hard, red, circumscribed swelling on the left forearm, similar to the others; in examining which, found the remains of an irregular vaccination, of which Dr. Buckingham first learned the date as given above.

15th. Swelling of right leg decidedly less; that of the left leg hard, red, and excessively tender. The right elbow was red and swollen. The right eye red, swollen, and painful about the orbit; no conjunctival redness; tears trickling over face; pulse 120, full, soft, diastolic; respiration slow and distinct, with occasional

sighing; no delirium; tongue perfectly steady, when protruded; face somewhat livid; no dejection for two days, except from enemata.

18th. Had a good night; pulse 112; respiration 16; nose much swollen, dusky, red, and painful; about a dozen papules, hard, red, and shot-like, scattered over forehead, face, back, and legs; no glandular enlargement. 12 M., a few more papules on abdomen; the others are becoming pustular, and a few are umbilicated.

19th, 8½ A. M. Two dejections, with urine; tongue dry, black, and cracked; redness and swelling of whole upper face; papules increasing in number, and pustules in size; a few of them umbilicated; no glandular enlargement.

20th, 10 A. M. Pulse 120, more firm, but not so full; respiration 32, laboured, two rules; numerous black, pasty dejections; took one of brandy in the night; restless, and occasionally wandering; easily roused, and speaks sensibly, but soon falls asleep again; pustules increasing in size and number, some of them as large as good-sized peas; knuckles of right hand swollen; both sides of face red, swollen, and oedematous; right leg of normal size, and appears well; left leg the same, with the exception of slight tenderness; swelling of left forearm soft and fluctuating; no glandular enlargement, nor mark of absorbents.

9 P. M. Constantly delirious; unable to drink; frequent involuntary dejections and urine; hands tremble, pulse 134, feeble; respiration 36, noisy and husky; sounds and impulse of heart normal; many of the pustules drying; scab of vaccination came off arm; erythema and oedema of scalp.

21st, 10 A. M. Delirious all night; takes nothing; insensible; no dejections; pulse 134, soft, and moderately full; respiration varies from 30 to 40, occasionally like that in hydrophobic paroxysm; heart's impulse strong; first sound loud, second sound scarcely perceptible.

6¼ P. M. Died. The body was removed early next day. No autopsy allowed.

As far as Dr. Buckingham could learn, there had been no sick animal on his farm, and so far as known, the patient had had no communication with any such, nor had he any occasion to handle hides.—*The American Journal of the Medical Sciences*, July, 1850—pp. 96-99.

Doctor Paul F. Eve does not admit the possibility of the inoculation of erysipelas by vaccination, as will be seen from the following extract from his article on the health of the Southern Army:

"Erysipelas by Vaccination. In regard to the inoculation of erysipelas by vaccination, independent of a peculiar atmospheric influence, and irrespective of some adventitious circumstance connected with a wound, I am not prepared to admit. We are all familiar with the idiopathic variety of this affection attacking the cutaneous and mucous surfaces, at times, too, becoming epidemic, and apparently in affinity with purpural peritonitis, and we know the traumatic type; but surely this disease does not originate from a specific virus. It is evidently infectious, but not, I believe, contagious. A distinguished surgical writer, admitting that it is inoculable, states expressly that it would be impossible for it ever to appear in a sound individual.

There, then, must be a predisposition in the general system, it would seem in every instance, usually induced by malaria, before it is developed. And if this be true, namely, that the attack depends for its origin upon a peculiar state and condition of the patient's health, is it not then unwise, not to say erroneous, to suppose that erysipelas occurring after vaccination is due to a poison escorted by vaccine matter into the system? I do not, therefore, believe it inoculable by this little operation."

The view maintained by Hippocrates and his followers, that Erysipelas was a disease originating from some intestine commotion of the humors, and that the offending matter was thrown off or eliminated by means of the skin, has been held by a large number of writers, with various modifications and slight additions up to the present time. The French writers especially advocate this view, and as a general rule deny the contagiousness of Erysipelas. The English writers, on the other hand, are almost unanimous in considering the disease as capable of propagating itself by contagion under certain circumstances. Dr. Cullen admitted a species of Erysipelas capable of throwing off contagious emanations. He says, "This disease is not commonly contagious, but as it may arise from an acrid matter externally applied, so it is possible that the disease may sometimes be communicated from one person to another."

The first well-authenticated facts militating against the old notions, and proving the contagious nature of Erysipelas, were published by Dr. Wells in 1798: for although Sauvages, in his "*Nosologia Methodica*," published thirty years before, admits an *Erysipelas contagiosum*, his views are obscure and his authority doubtful, as the epidemic of Toulouse in 1715, to which he refers in support of his opinion, appears to have been Scarlatina, and not Erysipelas. The examples brought together by Dr. Wells, in which this complaint appeared to be unequivocally propagated by contagion, have been sustained by similar cases, described by Pitcairn, Stevenson, Gibson, Lawrence, Gregory, Elliotson, Arnott, Watson, Rogers, Goodfellow, and other English Physicians.

The question of the possibility of communicating the poison of Erysipelas along with the virus of the vaccine disease, is intimately associated with that of the contagiousness of Erysipelas.

There was a diversity of opinion amongst the Confederate

surgeons with regard to the contagiousness of Erysipelas. This diversity of opinion was clearly referable in some cases to dogmas embraced during education, and to a want of careful and extended observation, and investigation of the origin, and mode of propagation, of the diseases incident to camp life. The reliability and value of the testimony of men upon such questions, clearly depends, not merely upon the extent of the field of observation, but also upon the mode in which, and the intelligence with which, the phenomena are investigated.

Many cases occurred during the progress of the war, in which Erysipelas was clearly referable in its origin and spread to the crowding together of large numbers of sick and wounded, in ill-ventilated hospitals.

The following communication from Dr. J. C. Nott, of Mobile, Alabama, illustrates, not only the dependence of Erysipelas upon crowding, but also shows that in such cases, in like manner with Hospital Gangrene, the disease is best eradicated by scattering the patients and giving them free ventilation. It would be surely unwise and unphilosophic to refer the origin of Erysipelas in such cases to an atmospherical influence, for the disease was most prevalent and most fatal in the most crowded hospitals, and was most speedily and effectually destroyed by breaking up those sources of contagion.

No light whatever is thrown upon the subject, by declaring the disease *infectious* and not contagious in crowded hospitals. We can only refer the propagation of infectious diseases to the exhalations from the sick, or from the excretions of their bodies, which act upon the extended surface of the lungs and skin of those immersed in the infected atmosphere: and we know that in the case of the two most *contagious* and *infectious* diseases, Small-pox and Measles, the diseased actions may be propagated in both ways by the inhalation of the exhalations of the sick, as well as by direct contact with the morbid matters.

MOBILE, 21st Nov., 1866.

DEAR SIR: Your letter came to hand yesterday, together with two Nos. of your Journal. I am sorry that I have no notes or statistics relating to Hospital Gangrene. My connection with the army was in the Command of Gen. Bragg, commencing

about six weeks before the battle of Shiloh. I had, it is true, been the Medical Director in Mobile for some time previously, but we had no wounds to deal with. Very soon after we got to Corinth, all sorts of camp diseases prevailed among the troops—diarrhoea, typhoid fever, &c., and erysipelas. The Colonel of a regiment came to me and begged me to visit a small brick church in the suburbs of Corinth, in which his men were dying at a fearful rate with Erysipelas. On visiting the church, I found some seventy or eighty sick and wounded men crowded together in a small church, and about one half of them with Erysipelas. There had been daily skirmishing going on, and about one fourth of the men had been wounded. The disease attacked those wounded, as well as others, indiscriminately. Many of them were dying of Erysipelas of face and scalp, who had not been wounded, and I never saw a more revolting scene than this hospital presented. I ordered it to be evacuated at once, and the patients to be removed to tents, at some distance off in the open field. The effect was immediate and salutary. The Erysipelas ceased to attack others, and the health of the command improved rapidly.

At the same time above alluded to, we had some cases of Hospital Gangrene among the wounded in different hospitals, up to the time of the battle of Shiloh. Being occupied very busily in office as Director of the Post, I had no time for visiting hospitals, and the battle of Shiloh coming off soon, and there being very little hospital accommodation, we were compelled to send off in every direction 10,000 wounded and as many sick. So I saw very little of what occurred among our wounded.

I afterwards went into Kentucky; was at the battle of Perryville, and other smaller battles; but here we had to leave our wounded behind, after every battle.

So really my experience has not been extensive or satisfactory in Hospital Gangrene. I have seen a good many scattering cases during the war, and have found them best treated by the application of Nitric Acid, Iron, tonics, stimulants, and good diet.

On the whole, then my observations and information are too indefinite to be worth much, and I write more to state the simple fact that we did have cases of Hospital Gangrene before and after the battle of Shiloh, and I looked upon it as close akin to Erysipelas.

Very Respectfully, Yours, &c.,
Prof. JOSEPH JONES, Nashville.

J. C. NOTT.

It will be seen from the following statistical information and sanitary report of the Moore Hospital, Manassas Junction, Virginia, for the month of January, 1862, that in this hospital, which received the worst cases of Typhoid Fever and Pneumonia, and which was liable to sudden and unavoidable crowding of the sick, Erysipelas attacked almost universally the patients operated on, only two escaping.

"MOORE HOSPITAL," MANASSAS JUNCTION, VA., February 7, 1862.

THOS. H. WILLIAMS, Surgeon C. S. A., Medical Director Army of Potomac:

SIR: I have the honor to forward the report of the "Sick and Wounded" of the

Moore Hospital, for the month of January. The face of it shows only 235 patients admitted, while 77 of these have died—a fearful mortality, I confess—and did it extend to all diseases treated, would soon decimate our army. But when it is recollected that the 235 men kept here were picked out of over 2,900 that have passed through and were sent further back, and that those kept are the sickest—in fact a number came in moribund, others dying from six to twenty-four hours after their arrival—the mortality does not appear so appalling. At the beginning of January, there were remaining 114 sick and convalescents; of these 25 died during the past month, making the mortality 102. The report shows 37 cases of febris typhoides, with 17 deaths, which is, strictly speaking, not true, as there have been but 4 or 5 cases of well-developed typhoid fever in the wards, and those so diagnosed are, in the majority of cases, simple continued fever, taking on a typhoid form but wanting in all the particulars of typhoid fever proper; and, I feel confident, was there an opportunity afforded for post-mortem examinations, they would be found wanting in the pathological changes peculiar to the disease.

There were 128 cases of pneumonia treated, with a loss of 45, almost 36 per cent., though not large when the condition of the patients at the time of entering the hospital is taken into consideration; a large majority of the cases are sick from three to ten days in camp before they are brought to the hospital. Such cases presenting bad symptoms, but still not necessarily of a fatal character, after a ride in an ambulance or wagon of three or five miles over a rough road, are placed beyond redemption. Stimulants and carb. ammonia may revive the vital spark, and the man live for several days, and occasionally, I am happy to say, has elasticity enough about his constitution to get well. As an evidence of the fatality caused by surrounding disadvantages, I have simply to refer to some ten or twelve cases of pneumonia in my nurses where every case has recovered, each one of them showing the good effects of antimony in the early stages of the disease.

Those sent from this place to general hospital, have been convalescents sent further back to make room for the sick. They have been South Carolinians and Mississippians, and were sent to Charlottesville and Warrenton.

The number of furloughs (47) is more for the number of patients; but when it is considered that all of the wounded—at least 60—from the battle of Drainesville, were here, that will be accounted for.

I may add that the two cases of erysipelas were purely idiopathic, and in the ward where all of the worst wounded were, there was quite a number of other cases there, arising from any little operations performed, such as removing a bullet or spicula of bone, but two patients operated on excising; on one of these, I ligated the carotid artery, in the other amputation of the thigh was performed. The latter operation was performed three weeks since, and the same day a bullet was extracted from the shoulder, which immediately took on erysipelatous inflammation, whilst there has never been the slightest symptoms of it about the amputation. In several of these cases, and especially the idiopathic, the inflammation was not confined to the skin, but extended to the sub-cutaneous areolar tissue, forming what Dr. Stone, of New Orleans, says is different from erysipelas, and what he calls, "subcutaneous areolar inflammation," never running its course without suppuration, and occasionally to an enormous extent, invariably presenting typhoid (low) symptoms.

I am, Sir, your ob't Serv't,

J. F. BELL, P. A. C. S.,
Surgeon in Charge.

These examples might be multiplied, but these are believed to be sufficient to illustrate the experience of many Confederate surgeons, upon the intimate relations of Erysipelas in its origin and spread to such diseases as Hospital Gangrene which were known to be contagious.

On the other hand the armies were never so healthy, and the wounded were never so free from Erysipelas, as during the most active campaigns.

The army of General T. J. Jackson, (Stonewall), during its active campaign in the Valley of Virginia, was remarkably healthy, and the wounded, as I ascertained by an examination of the records of several of the largest hospitals, connected with the Department commanded by this distinguished soldier, were exempt to a great degree from both Erysipelas and Hospital Gangrene. This immunity was due to several causes, but chiefly to the active habits and good morale of his soldiers, to the comparatively abundant supplies of this rich country, and to the large and commodious hospitals established at Staunton and other eligible points in this elevated and healthy region. The truth of this assertion will be sustained in the following Sanitary Report of his Medical Director, Surgeon Hunter McGuire:

NEW MARKET, VA., April 15, 1862.

S. P. MOORE, Surgeon General, C. S. A.:

SIR: I have the honor to forward the consolidated report of sick and wounded, and the return of the Medical officers, serving in the Army of the Valley of Virginia for the month of March, 1862, (Maj. Gen'l Jackson's Command).

Though subjected to long, and sometimes forced marches, the health of this army was better during the month of March than during any other since its organization. It is a fact well known to Regimental Surgeons and Commanders, that the numbers reported sick during marches, even when they are long and fatiguing, provided the weather is clear and dry, is less than that which occurs when troops are stationary, and subjected to the ordinary duties of camp.

Towards the end of the month, recruits and drafted men were added to the regiments, and the amount of sickness increased, indeed the large proportion of those reported sick, belong to the men recently attached to the regiments, who are not yet inured to the hardships of a soldier's life. I enclose also a list of the killed and wounded of this army, in the engagement near Winchester, March 23, 1862. It numbers sixty-one killed, and three hundred and sixty-one wounded. Some of the latter were mortally wounded, and have since died, which increases the number of dead, as far as known, to eighty-eight, and proportionally reduces the number of wounded. One hundred and fifty-seven of the wounded were removed from the

field, the rest fell into the hands of the enemy. It is gratifying to know that our dead were decently buried by the citizens of Winchester, and that our wounded have received every attention from the physicians and ladies of that place.

Very respectfully, your obedient servant,

HUNTER M. GUIRE,
Medical Director, Army of Valley of Virginia.

Whilst we do not at all deny, that Erysipelas at times prevails as an epidemic, and appears to be produced by some general epidemic influence, and that in many cases the disease may be most plausibly accounted for, by sudden changes of atmospheric temperature, along with considerable moisture, together with derangement of the bowels, and the effects of particular articles of food; at the same time there are facts to show that this disease is at times, if not always contagious.

Neither would we be understood as insinuating, that instances of its transmission by contagion, are common in private practice, for isolated cases frequently occur in private families in which no member of the family and no nurse contracts the disease.

The origin and spread of Erysipelas in Hospitals, will depend upon the hygienic condition of the wards, and upon the state of the constitution of the patients.

Many of the Confederate Surgeons appeared to be aware of the dangers attending the indiscriminate use of sponges, dressings, and uncleaned wash bowls, when erysipelas was present in their wards. When wounds were cleansed with sponges or rags which had been used on erysipelatos patients, it was frequently observed that the disease appeared; and such propagation appeared to be clearly referable to the transference of the contagious matter.

It can be shown therefore that the evidence of contagion in Erysipelas rests upon nearly the same grounds as in the well known contagious diseases, scarlet fever, measles, and Typhus fever.

Many of the British Physicians and Surgeons, entertain but little doubt of the connexion, if not the identity of Erysipelas with Puerperal fever. Without entering into an extended examination of the facts upon which this view rests, it will be suf-

ficient to recall the well known fact, that inoculation with the fluid of a female who had died of puerperal fever, is a most fatal source of diffuse cellular inflammation to the dissector.

Dr. George Gregory in his Lectures on the Eruptive Fevers, says that he had heard of a case, where vaccine matter taken from the arm of a child laboring under erysipelas, had communicated both diseases.

And finally Dr. Willan has testified, that if a person be inoculated with the fluid contained in the phlyctenae or vesicles of a genuine erysipelas, a red, painful, diffused swelling and inflammation analogous to erysipelas is produced.

This experiment has not as far as we are aware been repeated; and with such a direct demonstration of the possibility of communicating erysipelas by inoculation, we are at a loss to know upon what principles of reasoning, authors who have never performed a single experiment themselves, assume the right of setting aside the assertion of Dr. Willan.

By these facts therefore, as well as by those which occurred during the recent war, amongst the soldiers and citizens of the Confederate States, we are justified in drawing the conclusion, that it is possible to communicate the poison of Erysipelas, through the medium of the vaccine matter.

The practical conclusion which we draw from this discussion, is that:

As far as possible soldiers, especially during long and fatiguing campaigns, and when crowded in hospitals and barracks, should be vaccinated with the lymph or vaccine virus from young healthy children. It is best, both in Civil and in Military practice, not to use the vaccine virus from the arms on soldiers, because their mode of life is an artificial one, to a great extent: a stereotyped life of restraint and hardship, and of great sameness of diet, and consequently a life liable to great excesses and irregularities of habits, and to great and sudden variations of health, as well as to slow and imperceptible deterioration of the nutritive fluids.

The quality of the vaccine virus, will depend in great measure upon the manner in which the nutrition of the body is per-

formed. We use the word nutrition in its largest sense. Vaccine matter obtained from the arms of the feeble and often scorbutic convalescents of crowded civil and military hospitals, is wholly unfit for the propagation of the vaccine disease. Of all places, *civil and military Hospitals* are the *very last*, to which the profession should look for supplies of vaccine matter; and yet during the recent war, it was in the crowded hospitals that vaccination was most diligently, perpetually, and indiscriminately performed. In these most destructive centres of contagious diseases, of Typhoid fever, Erysipelas, Hospital gangrene, and Pyæmia, the so-called vaccine matter passed from soldier to soldier in an endless round. Is there any marvel that under *such a system, enforced by military law*, the matter should have progressively deteriorated, and the accidents of vaccination, (Spurious vaccination) have become both common and serious?

SECTION VII.

FRESH AND DRIED VACCINE LYMPH AND SCABS FROM PATIENTS SUFFERING WITH SECONDARY OR CONSTITUTIONAL SYPHILIS, AT THE TIME, AND DURING THE PROGRESS OF VACCINATION AND THE VACCINE DISEASE.

We examined at different times, during the progress of the recent war, and also had under treatment, various skin affections, which presented the characters of the cutaneous diseases, characteristic of secondary Syphilis, which were directly traceable to impure vaccine virus. I saw several cases in which enlarged buboes in the axilla and groin accompanied the peculiar skin affection induced by impure vaccine matter. No such results followed vaccination as performed by myself or immediately under my direction during the war: these accidents were avoided in my civil and military practice, by adhering rigidly to the rule of using the lymph from the arms of healthy children and infants: the opportunity therefore did not present itself of observing and carefully noting the disease in its first stages. The cases resembling constitutional Syphilis and which were said to

have resulted directly from vaccination, which came under my observation and treatment, were as a general rule of long standing, and had been collected from different hospitals, and from various regiments, serving in widely separated districts.

In the summer of 1863, I examined a large number, and if my memory is correct, over two hundred cases of severe skin affections and general constitutional derangement resulting from vaccination, in the large hospitals in and around Richmond, Virginia. In these cases, as well as in those examined in other parts of Virginia, South Carolina, and Georgia, great difficulty was experienced in tracing the impure matter to a definite source, that is to the point at which it became contaminated or deteriorated. I do not wish to be understood as asserting or insinuating that this large number of cases presented the symptoms of secondary Syphilis: so far from this it appeared to me that those cases which presented the most complete resemblance with constitutional Syphilis were not as numerous as those which were clearly referable to scorbutic and other deranged conditions of the system induced by fatigue, exposure and bad diet.

During the progress of the war, the subject of the relation of vaccination to constitutional Syphilis, engaged my most anxious thought, and I had determined to make it a special subject of investigation in the Field and General Hospitals, immediately upon the completion of my investigations upon Typhoid fever, Malarial fever, Small Pox, Hospital Gangrene, and Pyæmia, believing that a correct solution of this difficult and important question was to be obtained only by a personal examination of the cases as they arose in the regiments serving in the field, and by a careful collection and examination of the testimony of the regimental Surgeons and Assistant Surgeons. From experience gained in other investigations in the Field and General Hospitals, I was well aware that such labors required much time and were beset with many difficulties. From the terrible drain upon the Confederate States for men, the hospitals and convalescent camps were subjected to the most rigid scrutiny, and all men not absolutely disabled from every kind of duty, were at the earliest possible moment transferred to clerical and light duty in the Quarter-

master, Commissary, Medical and Purveying departments. From the great disparity of numbers, and from the immense extent of country in which the operations were conducted, the Confederate troops were in perpetual motion. The same soldiers, in the course of a few months, conducted fatiguing campaigns which extended over entire States, and fought bloody and desperate battles with superior forces in localities separated by hundreds of miles. Whole armies that had been victorious at some remote portion of the border, or of the Atlantic and Gulf coasts, were suddenly transported by railroad, across the entire Confederacy, to take their immediate part, without rest, in the bloody battles of the mountains of Tennessee and in the valleys of Virginia. These difficulties were experienced to a greater or less degree by every medical officer who undertook the investigation of this subject; and it has been rendered still more obscure, by the sudden manner in which the struggle terminated, and by the loss of the most extensive and valuable reports on file in the Surgeon General's office at Richmond.

I have sought to remedy, in a small degree, these defects, by addressing inquiries to a large number of those who formerly occupied positions in the medical service favorable for the investigation of the causes of the accidents following vaccination. It must be confessed that up to the present time, the replies received to these inquiries, have been wanting in that full and accurate detail of individual cases, which is so necessary to the proper solution of the question, whether the lymph or scab of a vaccine vesicle may, beside its peculiar virus, contain another infectious principle, as that of Syphilis.

The affirmative of this question was held by many, both in civil and military practice; and a number of the Confederate Surgeons, boldly took the ground that secondary Syphilis could be communicated along with the vaccine virus, and especially when the dried scabs were employed. In the records upon this subject, which we examined in the Surgeon General's office in the Confederate Capital, this view was clearly announced. Several of these reports had been prepared in accordance with a direct order issued by the Surgeon General, directing a careful investi-

gation into the origin and causes of spurious vaccination. The history, and results of a portion of the investigations ordered by Dr. Moore, are given in the following letter from my friend, Professor S. M. Bemiss, M. D., now of the Medical Department of the University of Louisiana. Dr. Bemiss enjoyed most extended opportunities for the investigation of this subject not only during his connection with the Army of Northern Virginia, but also during his efficient service as Assistant Medical Director of the Army of Tennessee.

NEW ORLEANS, November 21, 1865.

PROF. JOSEPH JONES, University of Nashville;

MY DEAR SIR:

Yours of the 9th instant, reached me to-day. I regret that I can furnish you no information likely to be of service to you in the investigation you have undertaken. During the month of March, 1863, while connected with the army of Northern Virginia, Medical Director Guild was so impressed with the importance of this affection that he ordered a committee of investigation into the extent of its prevalence, its causes and nature. I think the committee limited their inspections to those regiments only whose medical officers had reported the presence of this "Spurious vaccination." The committee consisted of Surgeons R. J. Breckinridge, now of Houston, Texas, Herndon, of Fredericksburg, Virginia, and ———, of North Carolina. I was not officially connected with the committee, but accompanied it from motives of professional interest. I kept many valuable notes in reference to the appearance of the ulcers and their history; but at the close of the war my camp chest was lost and with it all my MSS. My recollections are that the cases of spurious vaccination were most numerous in the 12th and 16th Ga. Regiments. In one of those regiments we found over one hundred cases of ulcerated arms and hands, and in many instances extending to the body and lower extremities. In one of these regiments the historical connection with Syphilis was most conclusive. They had all been vaccinated from the arm of a comrade of very dissolute habits, who had just returned from a leave of absence. This soldier was at this time in camp and presented unmistakable evidences of Syphilis. I do not think I err when I state that there was no chancre on the penis, but we rested our opinion of the existence of Syphilis upon the characteristic sore throat and eruption, and his confessions as to the recent existence of chancre. He had just returned from some little village in Georgia, and informed us that a physician practicing there, I think by the name of Russell, had taken matter from his arm and inserted it into the arms of a large number of young persons in his neighborhood. I regret that I cannot recall the names of the medical officers of these regiments, so that you might address them letters of enquiry. The "vaccination" in all these cases was done by the soldiers themselves and not by their medical officers, consequently, acting upon the popular idea that the larger the sore the more complete is the protection, they selected the worst sores for the propagation of the virus. I remember that the committee agreed

with regard to the worst of these ulcers, that their appearance and progress were so analogous to syphilides that they did not hesitate to class them as such. The usual treatment for Syphilis did not cure or brought these cases with any marked uniformity. I think we find a ready explanation of this observation in the condition of constitution and circumstances under which the treatment was instituted, poor diet, scurvy and camp life. During my long service in the western army I saw much of this form of disease, and in the majority of cases failed to connect it with Syphilis, either as to its history or characteristics. I treated one case in which the manifestations were decidedly syphilitic, but the soldier had suffered from constitutional disease in bad form for some year or more previously. In brief, toward the conclusion of the war I abandoned my previous opinion that all such cases were true syphilides, and was willing to admit that some of them could not be classed with those affections either by history, characteristics, or progress, and that we must refer them to the introduction of a poison differing from Syphilis, or to some peculiar constitutional crisis which determined the character of the sores. I refer you to the following gentlemen: Dr. L. Guild, Mobile, Alabama; Dr. James C. Mullens, —, S. C.; Dr. R. P. Bateman, Memphis; Dr. B. M. Wible, Louisville.

Very respectfully, &c.,

S. M. BEMISS.

Professor Paul F. Eve, M.D., of the Medical Department of the University of Nashville, as will be seen in the following quotation from his article "On the Health of the Southern Army," believes that Syphilis may be transmitted by vaccination.

"*Syphilis in Connection with Vaccination.*—From all I have heard and read on the transmissibility of Syphilis by vaccination, the question, from the evidence already accumulated, would appear decided in the affirmative. While I have seen nothing confirming this opinion, yet I do know that cases did occur in Richmond, Va., said to be corroborative of it, and that Medical officers in the Southern service were specially cautioned as to the source whence vaccine matter was derived. Since my return to Nashville, I find that the opinion obtains among the Surgeons of the United States Army, that in some instances syphilitic diseases have been definitely traced to the insertion of vaccine matter. My colleague, Dr. Briggs, called my attention recently to a case of this kind, of the source of which he entertains no doubt. I failed to see it, as the patient had left for the Hot Springs of Arkansas. When told that he had the secondary symptoms of Syphilis, he replied that was impossible, as he never yet had contracted the primary, though confessing that he was almost daily exposed to it. Two other physicians were consulted as to the affection, and from this history of the case were inclined to the belief of the patient, but stated it looked like venereal. It was subsequently ascertained that this person had been vaccinated from a girl of the town who labored under constitutional Syphilis. Not only was the arm in this instance made very sore, but buboes formed in the axilla, followed by ulcerations in the throat, copper blotches in the skin, nodes, &c.

"The possibility of communicating Syphilis by vaccination, was agitated in Italy as far back as 1846; and the transmissibility of this unfortunate contamination was

there definitely admitted in 1861, by a committee elected at a Medical Congress at Acoqui in Piedmont, at which it was believed that numerous cases had occurred in both children and adults, who had been vaccinated. The names of Pacchiotti, Parola, Ponza, Tassani, of Milan, who I met there in charge of a large hospital after the battles of Magenta and Solferino, in 1859, De Kalt, Hubner, &c., vouch for the accuracy of this report. The transmission of (syphilitic) disease has also been maintained by Lecoq, Rollet of Lyons, and particularly by Vernots in the Archives Générales de Médecine of Paris, 1860; and on this point, the admission of Dr. D. F. Condie, long known to occupy the front rank in the profession, and who has done so much for its literature, deserves serious consideration; and he publishes these words in a recent number of the American Journal of Medical Sciences:

"Let it be strongly impressed upon the mind of every physician, lest in his attempt to guard the system against one formidable malady, he inoculate with another, more insidious in its operations, but not less destructive."

"As to the contemporaneous presence of two constitutional diseases in the same patient, and the contagiousness of secondary symptoms of Syphilis, it is sufficient for us to state that at a recent meeting of the Academy of Medicine in Paris, the report from a committee, on which M. M. Velpeau and Ricord served, (than whom it may be safely asserted two better names for this very purpose never existed in the annals of the profession), decided both these questions in the affirmative."

Dr. O. Kratz, in the following report to the Surgeon General, on vaccination, originally published in the July number of the Confederate States Medical and Surgical Journal, (vol. i., 1864, p. 104), supported the view that Secondary Syphilis could be communicated through the medium of the Vaccine Virus.

On Vaccination and Variolous Diseases. By O. KRATZ, Surgeon, P. A. C. S.

The following remarks on Vaccination and Variolous Diseases have been suggested to me from my own experience. Spurious Vaccine and its deleterious influence on Vaccination, seem to me worthy of further investigation, as a subject hitherto not sufficiently appreciated.

In order to define my stand-point, let me state, at the outset, that Liebig's Theory of Fermentation is till now, the best to explain the phenomena of vaccination, and that all the anomalies occurring, may be best elucidated by this hypothesis. At the same time I do not feel warranted in subscribing blindly to it; but I think we have not any better as yet, and I simply adopt it in the same manner as I would have to conform to the atomic theory in treating about chemistry.

In vaccinating a subject we introduce, then, the yeast, the virus, into the circulation, to produce the fermentation and its result, the scab. If there is a certain substance in the system for the virus to react upon, the scab will be formed and the subject is vaccinated. If, on the contrary, this substance is entirely deficient or modified in some way or other, no scab, or an imperfect one, will be the result.

With very few exceptions, the good vaccine matter, will produce a normal scab on the subject never vaccinated before. The reacting matter in the system is elim-

nated, and by this process the liability to the infection of small-pox rendered impossible or greatly diminished. Possibly, in a long interval of time, this matter may be re-organized in the body, but never to its original state. I say never, because such a subject may be attacked by varioloides, but never by variola.

If this re-acting matter is re-organized as nearly as possible to its original state, the second vaccination will produce a scab also, but never a perfect one. It may be perfect for the protection of the individual on whom it appears, but it offers no guarantee for re-vaccination on other subjects. I call this a pseudo-scab. This scab may yet retain much of the original fermenting property, but not the same as the genuine. If this virus is used again for re-vaccination of an individual, its product will offer again less guarantees of being protective. Continuing in this manner, the scab will finally contain nothing but common suppurative matter—pus—as if taken from any other suppurating place in the body. The germ of the scab itself will be more or less modified and deviating from its normal structure.

As I have no book of reference on the subject, I quote the following from memory:

Some years ago, the Academy of Medicine in Paris investigated very closely the fact, if syphilis could be transferred by vaccination. The result obtained by repeated and most direct experiments was, that it could not be communicated by transmission of genuine Vaccine Virus, from one individual to another, affected with syphilis in any of its stages. Liebig's explanatory theory of fermentation holds good here. The Vaccine Virus will re-act only on certain substances in the system and ignore others entirely. We know, at the same time, that matter from a syphilitic suppurating surface will reproduce syphilitic symptoms on another subject.

I have had occasion to observe several well defined cases of Rupia Syphilitica produced solely by vaccination. Other respectable Surgeons, worthy of implicit belief, from their scientific attainments, have noticed the same and similar facts repeatedly.

These subjects had never Syphilis before, otherwise the inference would be doubtful or worthless altogether. Therefore, instead of having had vaccine virus inserted, they have been inoculated with Syphilis.

I have seen one case, where the product of the vaccination was *Serpigino rodens*, a frightful disease of, I believe, a cancerous character. Some cases had herpes excrucians as the result of vaccination on their arm.

The syphilitic cases had been treated for other cutaneous diseases without any material amelioration. The mercurial treatment removed the symptoms at once.

I have never seen anomalous results from vaccination if the following precaution was strictly adhered to: The vaccine matter used was taken from a healthy infant never vaccinated before.

The indiscriminate vaccination and re-vaccination from arm to arm has been, in my opinion, the principal cause of the deterioration of the vaccine virus, and of producing cutaneous diseases from vaccination. A second cause may be found in the fact, that the virus used is old and too rarely regenerated by passing it through the cow. Cow virus will fall only 1 in 100; good common virus will fall 3 in 100, if I remember right.—*Confederate States Medical and Surgical Journal*, July, 1864.

The testimony of Doctor Wm. F. Fuqua, of Virginia, for-

merly Surgeon of the 7th Florida Regiment, U. S. A., is clear and decided. Fifty-two Confederate soldiers, who had been inoculated with virus from the arm of a sailor who was laboring under Syphilis, presented the characteristic symptoms of constitutional Syphilis, as abscesses in the axillary glands, pain in the limbs and joints, sensation of dryness and ulceration in the throats, buboes, coppery colored spots, and loss of hair, and they were only relieved by syphilitic treatment. If these results of vaccination had been due to a depressed and scorbutic state of the blood, the syphilitic mercurial treatment would have greatly aggravated the diseased condition.

On the Communicability of Syphilis by Vaccination. By Wm. M. Fuqua, M.D., Appomattox County, Virginia.

On assuming charge of the Seventh Florida Regiment, late U. S. A., as Medical officer, I found fifty-two men who had been recently vaccinated, suffering from severe ulcers on their arms, at the site of vaccination. Some of these ulcers had scabbed, and to all appearances seemed to promise a speedy "return to duty." There were others, varying in size from that of a quarter of a dollar to that of a Mexican dollar. Their edges were hard, shining, and everted; in some few cases they were undermined. An ashy coloured slough covered their base, which was from time to time cast off. This, however, was not always a genuine slough, but a tenacious grey and partially organized exudation. These ulcers were offensive, and discharged pus freely. The redness circumscribing them, was limited, the limb but little swollen, and the pain of a burning, stinging character. In many instances, the lymphatic vessels were much inflamed, and the axillary glands, in each case, were more or less affected. Many of these patients complained of pain in their limbs; there was some febrile excitement, and their appetites had been much impaired. Having thus briefly described these ulcers, it may not be improper to remark upon the hygienic condition of the regiment.

At this time, I was doing duty at Knoxville, in the department of East Tennessee, and was quartered a mile from town, upon soil which had been previously occupied by troops, who had left the encampment in no praiseworthy condition. To the south, southwest, and west, lay the Holston river. The general health of the command was bad—the sick list comprising one-seventh of the command. The prevailing diseases were the malarial fevers and acute diarrhoea.

The first part of the treatment of these cases, consisted in their removal to a more cleanly and healthful locality; cleanliness of person and clothing was enjoined also. General directions were given as regards diet, and of maintaining their bowels in proper condition. The second part of the treatment was the local application of astringents in the milder cases, and escharotics, varying from the mildest kind to that of the most potent, in conjunction with the astringent lotions in the severe ones. Under this regimen, some few improved; none, however, recovered; by far

the greater number grew worse. Abscesses now began to form in the axillary glands; pain in the limbs and joints increased in severity; there was a sensation of dryness in the throats of many, which was speedily followed by ulceration. Our apprehensions were now fully awakened; each day we inquired more and more diligently for some new symptom which might be diagnostic. Coppery coloured spots now appeared upon two; the hair began to fall off in a third, and it was not a week before a syphilitic bubo, in its incipient stage, appeared in another. Heretofore, these cases had been denominated "spurious vaccination." Spurious they were, in one sense; but specific in another, in the strictest acceptance of the term.

It is hardly requisite for me to state, that these cases were placed upon syphilitic treatment, and we had the satisfaction, in comparatively short time, of seeing the greater number of them returned to duty. A few were sent to the General Hospital, one of whom died.

In conclusion, let me remark, that having mentioned to Dr. Frank Ramsey, then Medical Director of the Department, the nature of these cases, he requested me to make a report in detail concerning them, which was done, and in all probability found its way to the late Surgeon General's office.

Upon inquiry, it was definitely ascertained, that the virus for inoculating these patients was obtained from a sailor, on the coast of Florida, who labored under primary Syphilis at the time of vaccination.—*Richmond Journal of Medicine and Surgery*, June, 1866.

The following article by Dr. Frank A. Ramsey, of Memphis, Tennessee, contains an argument for the possibility of the transmission of Syphilis by vaccination, although its author does not feel justified in supporting this opinion in "a strictly professional disquisition." In a letter from Dr. Ramsey to myself, accompanying this paper, dated Memphis, November 15, 1866, he says: "The subject has occasioned me much thought, and incidentally some research, being on the watch for anything, however remote, at all applicable to the question. But I cannot say that I have formed any definite views regarding the question involved."

Abnormalities of Vaccination. By FRANK A. RAMSEY, M.D., Medical Director of the (Quondam) C. S. A.

It is after conference, regarded as proper for the following letter to be published. The subject matter of which it treats, was one of exceeding importance and interest, almost from the incipency of the intestine strife, in the Southern States, but has not yet had, in the professional periodicals, any exhibition of the attention it elicited, or any declarations of results of observation, or of investigation.

I do not deem it necessary to defend now, the course of thought taken in the letter, written under the peculiar circumstances connected with the period at which it bears date. It has, however, a reference to a particular opinion, which I would

not at any time, or under any circumstances, support in a strictly professional disquisition; that opinion had been hastily expressed, in the midst of official business, and for the purpose of producing a particular effect, which I honestly judged to be proper and best in the exigency.

Effects very nearly resembling rupia, followed vaccination, with presumptively pure virus, in so many instances, as induced the Surgeon General, to appoint medical officers connected with the Southern army, to the duty of tracing, if any, the connection between syphilis and vaccinia; and the prosecution of this duty gave occasion to the letter, now presented in the hope that it will lead others to record their observation, experiences and reflections, on the same subject; and with the intention on the part of the writer himself, under other and more favorable conditions to give the subject further consideration:

MEDICAL DIRECTOR'S OFFICE ARLINGTON, VIRGINIA, March 20, 1864.

DOCTOR:—Your note, of March the eleventh, informing me, that you had been appointed "chairman of a committee on the relation of vaccination to Syphilis," and making reference to my "report of last year," and asking me for "any further information relative to Spurious vaccination," has been received; and I take the first opportunity, offered in the performance of official duties, to reply.

I have no facts, which have occurred within the field of my own observation, directly relating to the subject, as stated by you; but, with your permission, will continue writing, until I have given you something of the operation of my mind, occasioned by your note.

I thank you for the honor you have done me, in preferring the request, and in the reference you have made to, I presume, a letter written by me, to a Surgeon at Chattanooga, a copy of which I deemed proper to forward to the Surgeon General. That letter was written, as I now write to you, *coram vobis*, and though I preserved a copy, it was left at Knoxville, and has doubtless fallen into the possession of the enemy. I am, therefore, prevented from making reference to it, as I am debarred from any ability to consult authority, or to refresh my memory, as I should, and would do, if differently situated. But, if I correctly remember, the letter was not of such a character, as to convey an idea, that the observations were of cases of *Spurious vaccination*. Indeed, the basis of the letter was furnished by observations of results, or effects following the introduction, or inoculation of vaccine virus undoubtedly pure. And though the results or exhibits were in their course, certainly not such as ordinarily present from vaccination, or as are usually recognized as essentially cow-pox; yet observations were not sufficiently numerous, or continued for a time long enough, to determine whether any, or the same degree of immunity from small-pox was occasioned in subjects thus affected, as in those who presented the ordinary course of the cow-pox disease. There were, however, practitioners of medicine, who were esteemed, in communities in which they labored, as capable observers, who affirmed that these subjects were as free from liability to small-pox, as those in whose economies the vaccine disease had exhibited nothing unusual, in deviation from its regular course. If, then, the scab was undoubtedly a pure vaccine scab, and the effect was perfect, or relatively perfect, immunity from small-pox, notwithstanding there was nothing observed from the application of the virus, until the production of the ultimate effect, at all like vaccine disease in progress, the disease, I think, cannot properly be termed spurious. To be spurious, the vaccine virus must not be in the scab, or the effect must be an absence of any protective energy having been impressed on the economy into which the scab had been introduced. Varioloid consists of exhibits in course, differing from variola in course, yet no one, I presume, would feel himself justified in terming it spurious small-pox, because it is known to proceed from small-pox virus, with commensurate small-pox, and leaves the economy it has affected, impressed with immunity from a future attack of small-pox. Varioloid is, then, not spurious small-pox, but small-pox modified in its exhibits in progress, through an economy previously impressed by the operation of the virus of cow-pox. Here the modifying cause is known.

So by analogy, the cases which gave occasion to my letter of last year, were, each, an instance

of modified cow-pox. The matter was obtained from Nashville, Tenn., from Atlanta, Ga., and from Richmond, Virginia, from Surgeons of reliability, and the same results were observed to follow upon the introduction of the several matters, in some instances regular vaccine, in others abnormal exhibitions; indeed, in many an approximation to the regular exhibition of original poison from cow matter, could not be discovered. And professional men, who were not destitute of reputation for capacity, affirmed, on the strength of observations sufficient to satisfy them, that the economies thus affected, were impressed with immunity from small-pox, as though they had passed through cow-pox in its regular exhibitions.

Then, to make complete the analogy I have instituted, it remains to establish by experiment, that true vaccine in its regular exhibitions, in one instance, or more, can be produced by the inoculation of matter from one of these economies. Which experiment, however, I will leave to some one with more curiosity and tenacity than I have, feeling satisfied myself, that they were cases of modified cow-pox. But in these instances, the modifying cause is unknown. It must, however, have obtained in union with cow-pox matter, in its passage through an economy peculiarly adapted, and, therefore, resulted in the scab, not altered from its ordinary physical appearance, because, as yet, not sufficiently imbued with the acquired and modifying contagion. Or, it must have been a peculiar condition of the individual economies, into which the vaccine virus was introduced. Or, it must have been telegraphic or celestial relationships sustained by the particular persons affected; or, as Sydenham's comprehensive term is applicable in giving expression to such relationships—"the epidemic constitution."

In my previous letter, I believe, I advanced this last as sufficient to account for the abnormalities which had been observed. It is the more easily assumed, and probably the more easily sustained position. I will, however, not undertake to defend it here, for, notwithstanding my great respect to the "epidemic constitution," when I am at the bedside of a patient, I can, when I am reflecting, readily comprehend, that either one or all the positions may be defended, as the source of cause in its influence modifying cow-pox.

Will vaccine virus become possessed of capacity acquired in its passage through an economy peculiarly diseased, to propagate such disease in other economies? The question thus stated, will, in some degree, embrace the relation of vaccination to Syphilis.

Whether there is truth in the doctrine which has been promulgated, that two distinct contagious diseases cannot exist at the same time, in the same economy, it is not amiss to make reference to it here; for if it is not true, the fact does not justify the assumption, that two poisonous causes cannot be introduced into an economy at the same moment, one having the office of vehicle for the other—does not justify an assumption, that two poisonous causes in the same economy, at the same time, can occasion no modification, each of the other, or the one of the other—and if it is true, the fact or modification is at once established. More directly assertive of the virus acquiring a modifying capacity, even to the complete destruction of original physical appearances, and exhibitions of effects, is the idea suggested during the year 1860, by Richard Denning, Surgeon, Plymouth-Dock, that "the vaccine disease, united with some other virus, may have effected the more active adhesion of variola." Denning's reviewer, from whom I received my information, says, "the hint deserves some attention, as a point of speculation which cannot be subjected to the test of experiment."

I only make reference to it as an assertion made long ago, that one virus may be modified by another; for I do not regard the poisons of variola and vaccinia as being at all identical. This, I think, is evident, if there is truth in the following statement: "Small-pox and varioloid will produce small-pox, but never cow-pox. Cow-pox will produce cow-pox, but never small-pox or varioloid. Cow-pox will prevent the occurrence of small-pox, or mitigate its severity, and lessen its mortality in the human economy. Small-pox having occurred by the human economy, is not preventive of cow-pox, if its poison be introduced by inoculation. Cow-pox, reproduced in the human system, inserted into the test of the cow, will produce cow-pox. Small-pox, similarly introduced into brute animals, will not produce small-pox. This last assertion is made by Wm. Woodville, M.D., London, 1860, and by others, perhaps before, and several times repeated, since, and within the past two years medical officers in the service have attempted, at Greenville, Tenn., to occasion small-pox in a cow, in one instance, and in a calf in another instance, using matter taken from a case of confluent small-pox, then under treatment, and inserting it under the cuticle, and introducing it into the stomach, mixed with food, and without any bad effects whatever, or

any disturbance of the health of the animals. I am aware, that observations have been published, seemingly different from this, but there is a want of explicitness in connection with their relation, which justifies a doubt of authenticity. But this, if you please, by way of parenthesis.

The most insidious of contagious poisons affecting the human economy is, probably, the syphilitic. It has, doubtless, occurred to almost every practitioner, to observe cases in which the subjects were known to have been treated for Syphilis, and afterwards, to have exhibited for many, very many years, entire health, when occasion, known or unknown, presented, and they offered themselves for treatment, affected with disease which the physician pronounced to be syphilitic, and which could not be cured, except by the administration of anti-syphilitic agents. The poison had remained latent, or dormant for those many years, only awaiting circumstances or conditions, favorable to the exercise of its capacity to affect. I had under my charge, for twenty years, a family, the children of which were generally healthy, whose father was treated for Syphilis from the age of nineteen to twenty-four; since which, he has enjoyed good health seemingly, in every particular. His children, however, were frequently attacked with illness, deemed sufficient to require my professional attention. No odds, how simple the attack, even though, when I first called, the evidence were nothing more than those of slight catarrh, I have never known them yield or mitigate, until one dose, or more, of a mercurial—generally calomel—had been administered. This I have ascribed to the presence in their economies of the syphilitic poison derived from their father, and exerting an influence retarding healthy development, or preventing the disappearance of symptoms of diseased action, not in themselves syphilitic. The cases cited in "Montgomery on Pregnancy," bear well on this point. A woman married a man with latent constitutional Syphilis. She became infected, which was first exhibited at conception, or in miscarriage, followed by secondary symptoms of Syphilis. A woman contracted Syphilis, was treated and recovered. A considerable time afterward she married. One, two, or three children were born, all affected with Syphilis. The husband died, and the woman married again, a healthy man; and to this husband, children were born, and all died, except one, affected with Syphilis; the exception had mercury and recovered. One of the children communicated Syphilis to the woman by whom it was nursed.

But the insidiousness of this contagion is more strongly exhibited in another case, cited by Montgomery. A woman, whose husband had constitutional Syphilis, gave birth to a child; which died with Syphilis in two months, the mother remaining wholly free from any exhibits of the affection. This husband died, and she married again, a healthy man. Four years after the former birth, she was delivered of a child, which, in a few months, presented the same syphilitic appearances manifested by the child of the first husband.

If these instances are, as observers affirm them to be, true, how little effort does it require for the mind to conceive the probability of a vaccine scab, having acquired the capacity from an economy affected with Syphilis, to propagate that disease? If a woman can remain in health, after sexual congress with a man affected with latent constitutional Syphilis, and yet years afterward, give birth to syphilitic children, begotten by a healthy man, it is within the bounds of legitimate assumption, to affirm that syphilitic exhibits may be manifested in an economy, by the introduction of vaccine matter, taken from an economy tainted with Syphilis, even though it is in that system in latency, and had never been developed.

Two of the cases which gave occasion to my letter of last year, were ladies whose husbands occupied prominent and responsible positions in society. Neither the husbands or wives were at all under suspicion of immoral taint. The wives were vaccinated, and for many months were affected with ulcerations, which, under other circumstances, would have been, without hesitation, pronounced to be syphilitic eruptions. They came under the care of Art. Arb. Surgeon Meadows, then, as now, in charge of Small-pox Hospitals in this department. He put them on the use of bi-chloride of mercury, and they both recovered in ten or fifteen days.

Permit me to summarize. Two contagious may be introduced into the human economy at the same moment of time, and connected with the same vehicle; or, one contagion may be the vehicle of another, and each may exert its own ultimate effects, the intermediate effects being the exhibitions of but one or the other of the contagious having made impression, or, the intermediate effects may be the exhibitions of one poison, which, having passed their course, the intermediate effects exhibiting the presence of the other poison, supersede and pass their course, Syphilis and vaccine. Two contagions may respectively modify each other. An illustration does not occur to me. One contagion may modify another, and while it is itself not subjected to a

modifying influence, exerted by the one it has modified, it may be modified by another contagion. Cow-pox and small-pox, cow-pox and Syphilis. The introduction of one contagion into an economy, may arouse another, which has remained dormant or latent, and unsuspected. Cow-pox and Syphilis.

An item relative to the treatment of small-pox:—Act. As't. Surgeon Meadows, in two cases of small-pox, occurring in children, employed croton oil, applying it on the third and fourth day of the active fever, to the breast, producing full and confident pustulation. The immediate effect was, certainly unpleasant—very considerable cerebral disturbance, evidently, in its intensity, ascribable to the croton oil pustulation: but he is convinced, that the course of the disease was shortened two-thirds, desquamation beginning on the seventh day, instead of during the second week; and that the eruptions were one half less than it would have been under other circumstances. He has, also, practiced opening each pimple, just as it assumed the vesicular character with the effect, he believes, of expediting the process, desquamation occurring one third the time sooner than usual.

I have written, Doctor, hurriedly, but I hope that I have not been so rapid, as to have failed wholly of interesting you, at least for the moment.

Very respectfully, your obedient servant,

FRANK A. RAMSEY,
Surgeon and Medical Director, P. A. C. S.

To JAMES BOLTON, M. D.,
Chairman committee on the Relation of Vaccina to Syphilis, Richmond, Va.—*The Medical and Surgical Monthly*,—May, 1866—p. 140-147.

Dr. Crawford, of Greenville, Tenn., was able to trace the impure virus which produced indurated ulcers and constitutional symptoms, to a single individual, and the disease thus disseminated by inoculation, yielded to the remedies best adapted to the treatment of syphilis.

GREENVILLE, TENN., Jan. 27, 1867.

PROF. JOSEPH JONES, M.D.:

DEAR SIR:—Having seen, in the January Number of the "NASHVILLE JOURNAL OF MEDICINE AND SURGERY," a circular letter addressed by you to the Surgeons of the late Confederate Army, insinuating inquiries upon "Spurious Vaccination," I desire to respond to your inquiries, and to communicate those facts in my possession, which may throw light upon this subject, which is fraught with so much interest to science and humanity.

During the winter of 1862 and 1863, I was "Surgeon in charge" of the "Madison Hospital" (Confederate) at this place, during which time over one thousand patients came under my charge. Small-pox made its appearance in the Hospital 15th November, 1862. In anticipation of the appearance of the disease, I had some time previous, procured a fresh supply of genuine vaccine virus by vaccinating some healthy children. In this way I had kept a fresh supply on hand since 1856. That is by vaccinating some healthy child every few months. I immediately ordered all patients then in hospital (350) to be vaccinated, both those that had been, as well as those that had not previously been vaccinated. The matter took well upon all who had not been vaccinated, and imperfectly in some cases that had been vaccinated. A "Pest-house" was established, and the infected, as soon as the nature of the disease was manifested, removed at once to it. The disease did not extend to the patients in hospital; but from time to time patients were admitted, many of whom

proved to be suffering with variola. But in no single instance was the disease communicated to those that had been recently vaccinated or re-vaccinated, and but six cases of varioloid occurred out of the 350 patients, all of whom had been exposed to the contagion of small-pox. There was great alarm, both among citizens and soldiers; for the small-pox cases were exceedingly fatal, owing to the want of proper comforts and attention. Out of 90 cases, 40 proved fatal. Neither the citizen nor soldier was satisfied of his immunity from danger, unless he could make a "scar" of some sort upon his arm. Consequently vaccination was perseveringly sought from the ugliest and foulest looking ulcers. The idea being with the masses, that vaccination loses its effects after a few years, and must be renewed: if a sore was not produced by matter from one arm, another was sought. This state of things continued without any mischievous effects until about the first of January, 1863, when Col. Clayton, then Commander of the Post at this place, who had been on leave of absence some weeks in North Carolina, returned with an ugly looking ulcer upon his right arm which was reported to be the genuine matter. The cry of *caraka* was raised, and it was not long until dozens, both citizens and soldiers, had this matter inserted into their arms. From this dates the history of "Spurious Vaccination." Col. Clayton had been successfully vaccinated some years before; but so soon as it was known that we were in the midst of the most loathsome of all diseases, I re-vaccinated him twice with genuine virus, but without effect. What the history of the case was from which he received the infectious matter, I never learned, for the Colonel could not find out. Col. Clayton was about 21 years of age, sanguine temperament, and in excellent health at the time he received the infectious matter into his arm. The ulcers I regarded at the time, and still regard, as caused by inoculation with *aphthous virus*. The cases ran an indefinite course of from three weeks to six months, and yielded only to *Blue Mass*, *Iodide Potassium*, internally, and *Sul. Copri*, externally. Some cases taken in their incipency, yielded in a few days to the external treatment alone.

It is proper to state that there was no tendency to scorbutic disease among either soldiers or citizens, and the infectious matter was equally as severe among the citizens as soldiers. The hospital was well provided with everything calculated to promote comfort and health. The patients were in good houses, had plenty of clothing, and rations in abundance, such as fresh meats, fruits, potatoes, cabbage, &c. There was no scarcity of these things in this country at that time, and what the Government did not provide, the citizens supplied with a liberal hand.

This "Spurious Vaccination" yielded no protection whatever from variola. I have seen more than a dozen cases of variola occur where there were large ulcers from this spurious virus, the patients thinking they were protected from the disease by such "scars." The spurious matter would take effect in all cases and all sorts of constitutions.

About this time orders were issued from Surgeon General Moore to procure fresh vaccine virus through the cow. I tried the experiment three times without succeeding. First on a cow seven years old, with a calf six months old. Then a young heifer two years old, and finally the calf. I inserted the matter in the teats, nose, ears and various parts of the skin, but never succeeded in getting a crust. Finally I fed the calf on the dried scabs mixed with its food, but it died without yielding me the much sought for treasure.

In August, 1863, the Confederate Army evacuated East Tennessee, and in September, 1863, the Federal Army took possession and held for a time. That army under Gen. Burnside was composed of new recruits, made up mostly of six months volunteers, many of whom had not been in the service three months. This same disease was among them. This army was abundantly supplied with anti-scorbutics, and fed with a liberal hand, and had never been exposed to hardships.

My best wishes for your success in your undertaking.

Yours sincerely,

S. P. CRAWFORD.

If such accidents had been confined entirely to the Confederate Army, or to the period of the war, when the citizens were to a greater or less extent subjected to unusual privations, and to the action of the most depressing causes, the views of those who denied emphatically the possibility of transmitting the poison of constitutional syphilis by the process of vaccination, would receive at least a show of support from the apparent dependence of the abnormal phenomena accompanying the vaccine disease, upon the depressed and deranged states of the system, induced by improper nutrition and physical causes.

It happened, however, that a large number of cases, which were referred by both citizens and physicians, to the contamination of the vaccine virus with the syphilitic poison, occurred in the quiet manufacturing community of Graniteville, after the close of the war.

Under the kind, liberal and efficient management of the intelligent head of the Graniteville Manufacturing Company, the operatives enjoyed comfortable dwellings and abundant supplies of nutritious and wholesome food. This class of the population of South Carolina were perhaps, more favorably situated, as to subsistence and support, than the great majority of the citizens of South Carolina, whose dwellings and barns had been laid in ashes, and whose social and agricultural system, the growth of centuries, had been so completely overturned, as to convert, without warning, the richest into the poorest.

The following report of Dr. W. F. Percival, of Aiken, South Carolina, is important, as being the most clear and intelligent statement, which I was able to obtain after considerable inquiry.

Report on the Communication of Syphilis through the medium of Vaccinus Virus, amongst the inhabitants of Graniteville and vicinity—1866. By W. F. PERCIVAL, M. D., of Aiken, S. C.

AIKEN, Nov. 15th, 1866.

Professor JOSEPH JONES, M. D.,

DEAR SIR:

I received your letter yesterday, and enclose a copy of my report on Spurious vaccination, with pleasure. I intended sending it to one of the Medical Journals, but have never had time to revise and prepare it for publication; the facts, however, are all stated.

I am with high esteem, yours very respectfully,

W. F. PERCIVAL.

Spurious Vaccination.—The Epidemiological Society of London, prepared four questions on the subject of vaccination, to be addressed to the most eminent Medical men in Europe. The third was as follows:

Have you any reason to believe, or suspect, that lymph from a true Jennerian vesicle, has ever been a vehicle for syphilitic or other constitutional infection? Among the number who responded, (over 400,) but three asserted their belief; twenty-seven in doubt, and nine had no experience. The rest asserted that it could not be done.

In a report from the College of the Faculty of Medicine, at Prague, the following language is used: "The possibility of inoculation with Syphilis by means of vaccination, (although not a single completely attested fact is known in this country,) is not to be excluded, for the conveyance of Syphilis, by means of inoculation, has been placed beyond a doubt."

In the face of so much testimony against the possibility of such an occurrence, the following report will perhaps throw some light on the subject.

About the last of April, 1866, I was requested to take charge of some cases of Spurious vaccination, at the manufacturing village of Graniteville. One hundred and fifty cases were presented for examination, men, women, and children, of all ages, from fifty years to twelve months. The larger proportion were operatives in the Factory, the others engaged in out-door work. There was every variety of constitution, from the pale and attenuated girl, to the hardy and robust laborer. Of the one hundred and fifty cases, ninety-three had been previously vaccinated. The appearance of the sore was identical in every case, viz: an excavated ulcer, of circular form, with raised and hardened edges and base. They varied in size, from one half to two inches in diameter, covered with grey or dark sloughy matter, and secreting unhealthy pus. There was no appearance of granulation. In some cases ulcers of a similar character, appeared on the arms affected; others on the opposite arm, and in a few on the lower limbs. In some, abscesses formed on the inside of the arm, and in nearly all the axillary glands were inflamed, and many suppurated. A thick and unhealthy crust would form, to be soon separated by the pus which accumulated beneath. In one case, there was a copper-colored eruption on the body and limbs; in two or three the hair dropped off. None of these cases were in the

primary stage. The disease had existed from three to eight weeks. Most of them pursued their ordinary avocations, as far as possible, and complained of no constitutional symptoms, or any loss of appetite.

The history of these cases, as given to me by the individuals first vaccinated, was, that they had obtained the virus from a man whom they afterward discovered to have had primary Syphilis. One was vaccinated from another, and so it spread. None of the ulcers had evidenced any tendency to heal. One of the worst cases was a man who, two years previously, had small-pox.

The usual treatment, both constitutional and local, for venereal ulcers, effected a cure in from three to six weeks.

It might be supposed that the predisposing cause of the ulcers, existed in a vitiated condition of the blood, dependent on local causes, but I had twelve or fifteen cases in other localities, some of them ten miles distant; all of these had obtained the virus with which they were vaccinated at Granville. All of these were strong and healthy individuals. Again, most of the cases reported had been vaccinated a short time previously and had progressed in the usual manner without any trouble, showing that no local cause had produced any derangement of their system.

As I did not see the individual from whom the virus was first obtained, I am unable to say that he really had primary Syphilis.

I cannot therefore draw positive conclusions from the above cases, and only present the report as information.

On the other hand, many of the Confederate Surgeons, entertained views similar to those announced by Dr. Habersham, and denied that any of the cases of Spurious vaccination were syphilitic in their origin or relations.

Thus Dr. S. F. Stout, of Pulaski, Tennessee, formerly Medical Director of the General Hospitals attached to the Army of Tennessee, in his reply (dated near Pulaski, Nov. 19th, 1866,) to my inquiries, says:

I am not satisfied that there occurred a well authenticated instance of the propagation of secondary Syphilis by means of the so-called Spurious vaccine matter. I think that the furious effects were chiefly produced upon persons already diseased syphilitic, scorbutic, or while living in an atmosphere infected by the causes of gangrene and erysipelas. A vast majority of these cases were those of individuals, who had been previously vaccinated, and in very many instances, the virus used was taken from the arms of re-vaccinated individuals. Thus common pus, and even ichor, was no doubt inoculated, which produced effects similar to those that are caused by a wound, received while dissecting a dead body, modified in many instances, no doubt, by the condition of the patient's health, and the morbid influences to which he was exposed.

Prior to my assumption of authority to take steps to stop the evil, I am satisfied that there were several errors in practice among our troops. First, the order requiring all soldiers to be vaccinated, whether they had been previously effectually vac-

inated or not. This order was literally interpreted and acted on by the superintendents of vaccination appointed by the Surgeon General. Secondly, many soldiers ignorant of the characteristics of genuine vaccine, vaccinated themselves, or each other, without consulting a Surgeon. Thus, no doubt, common pus, and even ichorous matter were often inserted. Thirdly, When variola first appeared in our army, so great was the fear of the disease, and the consequent anxiety to vaccinate everybody in the army, or in its vicinity, that the temptation to the Surgeon to use any virus within his reach, was very great. Thus much matter was used, which ought to have been rejected by Surgeons.

In my investigations I could not learn of a single well authenticated instance in which due care had been taken in the selection of the virus, whether in the form of lymph, or of the dried scab, that was accompanied by the evils of so-called Spurious vaccination, in a perfectly healthy individual, in an atmosphere uninfected by erysipelas or gangrene. Believing my conclusions to be correct, when as Medical Director of the hospitals I undertook to relieve the army of the evil, I made provision to supply it with virus taken only from the arms of healthy children, who had never before been effectually vaccinated. By the zeal and energy of medical officers designated at every hospital post, from supplies of virus obtained from the Surgeon General, S. P. Moore, and Surgeon J. C. Mullins, superintendent of vaccination of my department, appointed by me, the army in the field and the hospitals in the rear were amply furnished with virus from healthy children. No soldier was vaccinated with matter taken from another soldier. The supply was so abundant, that there was not temptation to use any other part of the dried crust than the vitreous, mahogany-colored portion. I recommended, that no soldier who had been vaccinated within a few years past, and who had the characteristic mark, should be re-vaccinated, unless positively known to have been exposed to variolous contagion; and especially, if he were labouring under any form of Syphilis, was scorbutic, or was living in an atmosphere infected with gangrene or erysipelas.

Under this practice, the so-called Spurious vaccination disappeared from our army, and before the close of the war it might be said to have ceased to exist in Georgia.

Having thus far entered into a statement of the impressions I have, and of facts bearing upon the subject, it may not be amiss to say to you, that my observations and experience during the war has confirmed my faith in the prophylactic powers of the Jennerian virus. I use the term Jennerian to designate that vaccine virus, which has been propagated from that originally supplied by Jenner. The immunity of so many thousands of soldiers and officers witnessed during the war, and the comparatively small number of the vaccinated who were attacked with variola or varioloid, enhance my estimate of the protective power of vaccine, rather than diminishes it, as has been the case with many, whose field of observation has been comparatively smaller than mine.

I have no data, by which to form an opinion, as to the relative frequency and nature of the foul gangrenous ulcers attendant upon vaccination in the United States forces. In the Second Section of the present inquiry, we have quoted the testimony of Dr. Hamilton to show that they were to a great extent, as in the

Confederate Army, referable to the depressed and scorbutic condition of the soldiers.

Dr. Woodward, in Circular No. 6, War Department, Surgeon-General's Office, p. 127, affirms that the accidents attendant upon vaccination in the United States Army, were generally regarded by the Medical officers, as "the expression of scorbutic or other cachectic conditions of the patients, and not due to any poisonous admixture with the vaccine virus; and it was frequently observed that the same scab which had produced a number of successful vaccinations, would, in other men vaccinated at the same time, produce the ulcers referred to."

It appears, however, that some of the United States Medical officers, held that a portion at least of these abnormal affections following vaccination, were due to the admixture with the syphilitic poison, as will be seen by the following extracts from an article on Spurious Vaccination, by Geo. H. Hubbard, M.D., late Brevet Lieut.-Col., and Surgeon U. S. Vols., published in the Philadelphia Medical and Surgical Reporter, February 10, 1866, p. 103.

On the last day of November, 1863, I reached Fort Smith, Arkansas, under an assignment to duty as Medical Director of the Army of the Frontier.

My attention was immediately called to several hundred men disabled in consequence of spurious vaccination, and a board of medical officers was soon after organized, by command of Major General Schofield, to investigate its origin, etc.

This Board made a detailed report, from which, from reports of other medical officers, and from personal observation, I was enabled to arrive at the following facts and conclusions.

It was definitely ascertained that the virus which caused all these cases came from persons who had been vaccinated in the rebel army, or by rebel Surgeons.

This virus was used by ignorant medical officers and by self-inoculation among the men, till more than five hundred were infected.

The Board reported that—"Soon after the operation was performed, the points at which the matter was inserted commenced to itch and inflame, and by the second or third day, pustules were formed, of a yellowish color, which rapidly increased in size, and in a few days burst. In some a scab formed, but in all, open ulcers were formed by the tenth day, and which furnished a thin ichorous discharge.

"At the time we examined the patients, some had well marked Hunterian chancre; some had large excavated ulcers, with edges elevated above the raw and surrounding induration; the centres, when not recently cauterized, were of a brownish hue—some, whose primary ulcers were about healed, had secondary symptoms,

such as swelling and ulceration of the glands in different parts of the body; while others had pain and stiffening of the joints.

"The disease was brought to the 1st Arkansas Infantry by deserters from the Confederate army, and in our opinion it is Syphilis."

The following is from my official report to the Surgeon General:—"I have no reason to believe that in any one case did this virus produce a true vaccine pustule, or had any of the protecting power of vaccination.

"The ulcers all possessed, in a greater or less degree, the well established peculiarities of venereal chancre, being of a specific and progressive nature, spreading in some cases to the size of a dollar, but usually about half that size; commonly round in shape, but often irregular, and usually of the depth of the true skin.

"All had ragged, elevated, indurated, and overhanging edges, little sensitive to the touch or even to caustics; while the bottom of the ulcer, (especially under these indurated edges,) was excessively sensitive.

"All discharged dark ill-conditioned pus, which in many cases caused painful excoriation of the surrounding skin, and when transferred to other parts of the body, reproduced ulcers like the original; in this way, chancres were produced on the penis in several cases.

"Cases precisely similar occurred in the Indian Brigade, stationed at Fort Gibson in the Cherokee nation.

"Acting Assistant Surgeon Miller, on duty at that post, reported as follows:

"Besides the cases occurring among the troops, it has spread among the people to an alarming extent by self-inoculation.

"In a large proportion of the cases, consecutive symptoms have appeared; supuration of the lymphatic glands in the axilla, sore throat, exanthematous eruptions, etc.

"The cases occurring among the troops have received the ordinary treatment for Syphilis, and in most cases with excellent results.

"The mischief was wide spread before the true character of the disease was recognized, so that few cases have had prompt abortive treatment, and many are, in consequence, permanently disabled.

"Nearly every case has required constitutional treatment, in addition to local treatment of the chancre.

"The milder caustic applications proving insufficient, in many cases, acid nitrate of mercury was used to clear away the indurated edges, when the ulcer usually healed rapidly under mildly stimulating applications."

"Six cases of well marked small-pox occurred in men who had previously suffered severely from this venereal inoculation.—*Med. and Surg. Reporter*,—Feb'y. 19th, 1866,—p. 103.

Up to the commencement of the recent civil war, the belief was almost universal that secondary syphilis could not thus be communicated by vaccination.

In the Papers relating to the History and Practice of Vaccination, contained in the Report of the General Board of Health,

presented to both Houses of Parliament, by command of Her Majesty—London, 1857—Mr. Simon called for the opinion of the profession at home and abroad on the general question.

"Have you any reason to believe or suspect (a) that lymph from a true Jennerian vesicle has ever been a vehicle of syphilitic, scrofulous or other constitutional infection to the vaccinated person; (b) or that unintentional inoculation with some other disease, instead of the proposed vaccination, has occurred in the hands of a duly educated medical practitioner?"

In answer to this question a writer in the British and Foreign Medico-Chirurgical Review (October, 1857, Review iii., Small-pox and Vaccination), quotes the opinions of Hebra, which may be taken as expressing in a logical and lucid manner, the belief of the majority of the medical profession at that time.

"This widely-grasping question (says Hebra) requires several separate answers, because queries are made,—

"1. Whether the lymph of a vaccine vesicle may, besides its peculiar virus, contain another infectious principle—e. g., that of syphilis?

"2. Whether constitutional non-infecting diseases, as, for instance, scrofula, may be transmitted by the inoculation of cow-pox matter?

"3. Whether a vaccine vesicle possesses such characters that it may easily be distinguished from other similar vesicles, blebs or pustules?

"(1.) The transmissible infectious principles which have hitherto been recognized, by means of inoculation, are, the syphilitic virus contained in the pus of a chancre; and the virus contained in the cow-pox vesicle, and the small-pox pustule. The question, therefore, simply is, whether these morbid poisons have ever been mixed? Whether inoculation has ever taken place with such a mixture? And what results were obtained by such an operation? It is well known that copious answers have, for some time past, been offered to these questions, chiefly the result of Sigmund's experiments. These answers agree in the following respects:

"Inoculation with secretions of this kind—viz., containing, as it were, several special poisons, either produced no effect at all, or only generated a chancre, by inoculating a mixture of pus from the chancre and vaccine lymph; and only cow-pox, by inoculating a combination of vaccine lymph and blennorrhagic matter. Hence one morbid state only was produced, either cow-pox or syphilis; the latter circumstance being a proof that both poisons are not *simultaneously transmissible*. This opinion is supported by the experience of Heim, Ricord, Bousquet, Taupin, Landouzy, Friedenger, &c.

"(II.) It is maintained in many quarters that the blood of persons suffering from secondary syphilis may serve as a vehicle to the infectious principle; but were even this theory found correct, it would have no prejudicial effect on the practice of vaccination, because we know from experiments made for the purpose (Heim), and

from accidental inoculation, that regardless of the quality of vaccine lymph, the latter may be inoculated from syphilitic upon sound individuals; and, on the other hand, from sound subjects upon such as are under the influence of systemic syphilis, without propagating syphilis along with the cow-pox.

"What has here been proved of syphilis must *à fortiori*, hold good as regards other constitutional morbid states, as direct inoculations with the secretions peculiar to these diseases have always yielded a negative result.

"But although it is abundantly proved, that scrofula, tubercular affections, rickets, cancer, and other blood diseases cannot be transmitted by means of their own secretions, or along with the vaccine lymph, we should nevertheless, if possible, avoid vaccinating diseased persons, because experience has taught us, as regards adults and children, that the phenomena of vaccination may awake—i. e., render worse—dermatitis affections, and that moreover, the cow-pox vesicle easily degenerates upon such individuals. These latter vesicles are nevertheless adapted for further propagation even when they take an imperfect development, because a positive result, a regular development of the vesicle, and sufficient protection against small-pox have been observed in cases where vaccine lymph was transferred from weakly, scrofulous, and rickety subjects upon perfectly sound individuals.

"(III.) Every morbid appearance on the cutaneous envelope has its own peculiar characters, by which it may be distinguished from all other similar phenomena; the vaccine vesicle presents, in the like manner, sufficiently striking peculiarities as to form, size, number, locality, and peculiarity as regards its course, to enable the observer easily to establish a distinction between the same and other vesicular, bullar or pustular eruptions."

We shall examine these doctrines and conclude these *Researches on Spurious Vaccination*, with an examination of the following questions:

(1st.) *The possibility of communicating Tuberculosis and Cancer by Inoculation.*

(2d.) *The possibility of communicating Secondary or Constitutional Syphilis by Inoculation.*

(3d.) *The possibility of communicating the poison of Syphilis through the medium of the Vaccine Virus.*

I. True Tubercle is organized; that is, it is composed of living cells, and during its growth it resembles, to a certain extent, fresh granulations. These soft fragile cells and nuclei, resembling the gland cells of the lymphatic glands, are to be regarded as the characteristic living element of tubercle. According to this view, Tubercle resembles malignant growths.

M. Villenin's researches appear to have settled the question of the inoculability of Tubercle. This observer affirms that he

had succeeded in reproducing tubercle by inoculation, again and again, in rabbits, not only when taken from the human subject, but also when derived from the cow; and farther, that the tubercular matter thus produced in one rabbit, could be in like manner transmitted to another. (*Gazette Hebdomadaire*, 1866).

Dr. Lebert, Professor at Breslau, has succeeded in introducing tubercle into the system by subcutaneous injection, and thus confirmed M. Villemin's experiments. Dr. Lebert's experiments were made with Guinea pigs and rabbits, and both grey and yellow tuberculous matter were employed, as well as liquid from a cavity: the nape of the neck was the spot chosen for injection, and the amount introduced varied from fifty centigrammes to a gramme, diluted and triturated with distilled water. The result of his experiments was the finding of tubercles not only in the lungs, but in other organs, as the liver, spleen, plurae and pericardium. In some experiments, the tubercles were found in large portions of the lymphatic system. Microscopic examination revealed the identity of the tubercles thus formed in animals by inoculation, with those of man.

Tubercle still farther resembles malignant growths, in that the original growth causes the formation of new tubercles in its neighborhood and thus gradually infects large tracts of living and previously healthy tissue. It is possible in many cases, by carefully comparing the symptoms during life, with the results of post-mortem examination, to trace the gradual propagation, of tubercle from a well defined centre.

It is not my design to discuss, at this time, the cause and mode of origin of tubercle, or its relations to inflammation, and to defective nutrition; my design has been simply to show that there are facts and experiments proving the possibility of transmitting the disease from one animal to another by inoculation. And whilst we are unacquainted with a single fact which illustrates in any manner the relations of vaccination to tuberculosis, at the same time it must be admitted that we need farther experiments and light upon this subject: and we know just enough to create a prejudice against the indiscriminate use of vaccine matter from scrofulous and tuberculous subjects. Dr. George

Budd, of London, in his valuable work on Diseases of the Liver, has recorded a large number of facts to show, not only that cancer may be disseminated by *inoculation*, or by the mere contact of a sound part with a part affected with cancer, without any direct vascular connexion between them; and by cancerous matter conveyed by lymphatics and veins to other parts of the body: but that cancer may even be propagated by inoculation, or by injection of cancerous matter into veins, from one animal to another.

The facts recorded by Dr. Budd, illustrate in the clearest manner the first two modes of the dissemination of cancer, in the human being; and to support the third proposition he cites the following experiments:

Professor Langenbeck, injected into the veins of a dog some pulp taken from a cancer which had just been removed from a living body. At the end of some weeks the dog began to waste rapidly. It was then killed, and several cancerous tumors were found in its lungs.

Another instance to the same effect, taken from a German periodical, is related in the Provincial Medical Journal for September 23, 1843. Some cells were collected from a black liquid in the orbit of a mare affected with melanosis, and were inoculated into the conjunctiva and lachrymal gland of an old horse. These merely caused a black spot on the conjunctiva, which extended very slowly; but about the sixteenth week after inoculation, melanosis of the lachrymal gland was very decided; it had invaded the whole organ, and pushed the globe of the eye forward. Some of the melanotic matter, taken from the same mare, was injected into the veins of the neck of a dog, who died suddenly whilst hunting, three weeks after the operation. There was found in the left lung a melanotic tumor, which was ruptured, and which contained a brown, coffee-colored fluid, abounding in cells.

So many instances have occurred of cancer of the penis in men whose wives had cancer of the womb, that many physicians have been led to believe that the disease in these instances was propagated by contagion. (On the Diseases of the Liver by George

Budd, M.D., Third Edition, London, 1857, chapter iv., pp. 388-416).

It would in like manner, be foreign to our purpose to enter into any speculations as to the cause of cancer, or into an examination of the question, whether the germ of the disease be a true parasite, introduced from without; or whether cancer is generated within the body, or of the materials of the body, under the influences of certain agencies.

We will have accomplished our purpose in recording these facts, if we succeed in directing the attention of the profession in this country, to the necessity of greater attention to the condition of the subjects selected for the propagation of the vaccine disease.

We proceed now to the consideration of the second and more important question, which relates to the propagation of one of the most destructive poisons in its action upon the human race.

II. The formal and persevering denial by eminent surgeons, that Secondary Syphilitic disease could be communicated by contact, and the adoption of this theory by a large and influential school, has inflicted much domestic misery and led to most unwarrantable and destructive carelessness in the process of vaccination.

The question of the communication, by contact and inoculation of Secondary Syphilis, is of vast importance in its bearing upon the human race, and should not be settled dogmatically—in fact it is not in any manner a question of belief, but of facts.

As early as 1498, Gaspard Torella affirmed that he had often seen the unweaned child infected by the sore breasts of its mother, and then bestowed upon its nurse, who fondled and kissed it, the same unfortunate endowments.

Many of the older writers appear to have entertained no doubt with reference to the possibility of communicating constitutional syphilis. The following testimony is from William Clowes, who wrote more than two centuries and a half ago:

I have also knowne divers persons infected, who have had in all other parts of the bodie manifest signes thereof, as dakers, tumors, ulcers, and venous pustules, &c. And yet in the parts aforesaid, no paine, or any signe thereof: so that their opinion is not to be observed, which affirme, that this disease is ingendred onely, by the com-

pany of uncleane persons: for I have knowne not many yeares past, three good and honest Midwives infected with this disease, called *Lues Venerea*, by bringing abed three infected women, of three infected children, which infection was chiefly fixed upon the Midwives fingers and hands, &c. What should I speake of young sucking children, whereof divers have beene grievously vexed with this disease, and some of them a moneth, two, three or foure moneths old, and some of them a yeare old, some foure or five yeares old, and some of them sixe or seaven yeares old, amongst which sort, I thought it good here to note a certaine wench, the daughter of one *Sore*, of twelve yeares of age, the which I cured, in the yeare of our Lord 1567, who was greatly infected with this sickness in many parts of her body, having thereon painfull nodes or hard swellings and ulcers, with corruption of the bones, and yet no signe in the most suspected parts, neither by reason of debilitie was able to have committed any such act, but it is not to be doubted, but that she received the infection, either from the parents, the which cure of some is supposed uncertaine, whether children begotten by infected parents, may bee cured or not: or else she was infected, as divers are, by sucking the corrupt milke of some infected nurse, of whom I have cured many, for such milke is engendred of infected blood, and I may not here in conscience overpasse, to forewarne thee good Reader, of such lewde and filthy nurses: for that in the yeare 1583, it chanced that three young children, all borne in this citie of London, all of one parish, or very neere together, and being of honest parentage, were put to nurse, the one in the countrie, and the other two were nursed in this citie of London: but within lesse than halfe a yeare, they were all three brought home to their parents and friends, grievously infected with this great and odious disease, by their wicked and filthy nurses: Then their parents seeing them thus miserably spoiled and consumed by extreme paines, and great breaking out upon their bodies, and being so young, sick and weake, impossible to be weaned, were forced, as nature doth blinde, to seeke by all meanes possible to preserve these poore silly infants, which else had died most pitifully. To be briefe, ere ever those children could be cured, they had infected five sundry good and honest nurses: I cured one of the children, and the nurse which gave it sucke, the other two children and their nurses were also cured by others, but one of the children lived not long after, as I was given to understand. Also friendly Reader, I read of late in a certain history, written by *Andrew Parry*, in his 2. book, interesting of the causes of *Lues Venerea*, which history indeed is worthy the rehearsal: "An honest Citizen saith, he granted his most chaste wife, that she should nurse the child which she was lately delivered of, if she would keepe a nurse to be partaker of the travell and paines: the nurse that she tooke by chance, was infected with *Lues Venerea*, therefore she did presently infect the foster child, and he the mother, and she the husband, and he two children which he had daily at his table and bed, not knowing of that poison which he did nourish in his own body and intrals. But when the mother considered and perceived, that her child did not prosper or profit by the nourishment, but continually cried and waxed wayward, desired me to tell her the cause of that disease, neither was it any hard matter to doe, for his body was full of the small-pocks, wheikes, and venous pustules: and the breasts of the nurses and mother being looked on, were eroded with virulent ulcers: and the body of the father and his two sonnes, the one about three yeares, and the other foure yeares of age, were infected with the like pustules and swellings that the child had: there-

fore I shewed them that they were all infected with *Lues Venerea*, whose beginnings, and as it were provocations, were spread abroad by the nurse that was hired, by her malignant infection. I feared them all, and by the help of God, brought them to health, except the sucking child, which died in the cure: and the nurse being called before the magistrates, was punished in prison and whipped closely, and had been publicly whipped through all the streets of the city, if it had not been for the honors of that unfortunate family." Thus we see children infected by filthy nurses, and sometimes nurses be infected by giving suck to such infected children. And now to returne to my former purpose, the disease, as saith *Nicholas Mass*, whose counsell and direction in the cure of this disease I have greatly observed. The disease because it hath a *flowing* matter, being once entred into any part of the body, proceedeth on from part to part, never resting until it hath corrupted the liver, with the ill disposition of this infection especially. When it toucheth any such part, as hath in it an apt disposition to admit such infection, as when the action or force of the agent is wrought and imprinted in the patient, fitly affected to receive the same forme, and so it disperseth itselfe through the whole bodie: likewise this sickness is many times bred in the mouth, by eating and drinking with infected persons, and sometimes onely by breathings: and *Masius* a learned Physician setteth downe for truth, that this disease may be taken by kissing, and sometimes by lying in the bed with them, or by lying in the sheets after them: also it is said to come by sitting on the same stools of easement, where some infected person frequenteth, and sometimes such as have been cured of this disease, fall into it againe by wearing their old infected apparell: all which causes of this disease I rather set downe, for that I would thereby admonish as many, as shall read this treatise, to be carefull of themselves in this behalfe, and to shun as much as may be, all such occasions.—*A Profitable and Necessarie Booke of Observations for all them that are burned with the flame of Gunpowder, &c.* By *William Clowes*. London: M. Dawson, 1637. pp. 151-2-3.

Gideon Harvey, in his "Venus Unmasked," published two hundred years ago, expresses similar views:

4. *First*, How many various ways doth the Pox exert its Contagion? No external part is impowered to transmit its infection immediately, except where its susceptibility: so we observe the Venereal parts to be infectory immediately upon the susception of virulency, but not through kissing, sucking of the breast, by sweat, or through any other parts but themselves. So the mouth that's infected by kissing, or sucking a thorough pockified whore's tet, is capable of immediately infecting another's lips by kissing, or any other part by sucking it, because the pocky Miasma are near; but not by copulation, or sweat, &c., because the contagion cannot be crept so far. Experience verifies this dictate. Is it not an ordinary trick of Wenchers (as *Mass* relates) to suck whores' tongues, and tet of their breast and yet those, whom they know have been pockified many years about their lower parts, and for that reason though their appetites are furious, yet dare not be dabbling, but the other they reiterate a thousand times over without the least hazard? An instance for the other part of the dictate, which I had from my

my first master in Physick, that wonder of Physicians *Prof. Joh. Antonid*, reader *London*, p. m. the profoundest Commentator on *Hippocrates* and *Celsus*, that ever any age presented, whom I heard that most famous *Professor Regius Guido Patin* institute the *Dutch Hippocrates*. He during his luculent practice at *Amsterdam*, had a Merchants Prentice in cure of an Gonorrhoe, and a blistered, or cankered like mouth; both symptoms he confest to have started upon him at the same time. The excellent Professor being curious and admiring at the rarity of such distant symptoms emerging at once, extorted an ingenuous confession from his Patient, upon pretence that it would facilitate and abbreviate the cure: the other without any longer suspense impudently told him, his tongue was as unfortunate as his tayl; a sort of Diabolick fatyrim, outvying *Arcinus flagellus de Principi*, and very like a *Dutch* invention. What ensued? this bastard at a *Bosse* (an invitation thats usually made to young folks, preliminary to all Weddings) accosted himself to two pretty Damsels, and being planted between them, oft flankt to the right, and in a kisse plodged his right hand man, and so to the left, and performed the like duty there. But the tragick event may imprint a dread upon all young women. A short time after their lips felt hot, inflamed, grew sore and ulcered, one named it the thrush, another a sore mouth; vulgar applications rather promoted than checked the evil, wherein they persisted so long that accessory accidents, as sordid ulcers of the palat and tonsils, nocturnal pains, &c. moved a jealousy of the fowl disease. Here you may remark, how innocently the poor lasses presumptured their fortunes. The reflexion of this relation upon the latter part of the dictate I commit to your own thoughts.

2. A Wench or Monsieur by that time they are thorough pockified, are infections in any part where ever the Pox bursts out, because the virulent seminaries are propagated quite through the body, which exhaling at the places affected, transport the contagion. What the *thorow-pox* is expect below; so that when the malady is transfused to so high a flood, its time for Nurses, Physicians, and all visitors to stand off: upon such occasions a person may be infected by drinking out of the same vessel (provided the spittle adhering be warm still) as we have heard of many; (*Leonardus Botallus* adduoth an observation of a patient of his, of a chaste and religious converse, who was stigmatized by a peculiar pledging of his familiar, then under a sore affliction of a *thorow-pox*. His lips inflamed, afterwards ulcered, his jaw bone grew carious, and was miserably racked with nocturnal arthritic pains.) By trying of a warm Pocky Glove; by succeeding a virulent Patient on a close stool; by shifting of him, or making his bed whilst the sheets continue warm; as *Neel*, *Moss*'s friend and Patient, who incurred this evil, by touching the sheets, one lay in, that was lame of a *Neapolitan* ulcer in his leg; and that old woman in *Harst's* observ. aged fifty-six, tending a Pocky fellow in his lying in, was seized of the same disease in as furious a degree as her Master: and by kissing, witness *Faccensius*, who knew a young man, that contracted this evil by oft kissing a fowl slut. The initial symptoms appeared about his mouth; his privities, which otherwise might have bin suspected, appearing free from all contagion. To this I'll parallel another; one Mrs. &c. then a pocky inhabitant of the *Hague*, having run the gantlop of several cures, Hydrotick and Mercurial, at last proved with child; her reckoning being expired, she was brought to bed of a Monster, in all particulars resembling a living child; saving the skin, which was abominably ciphered with spots and

botches. This object of *merry upon us* was committed to the care of a Nurse, the Infant aspiring to higher things, had the world adieu. But the unhappy Nurse had cause to curse her late Foster-child, her breasts and head ulcered, a *Cervix* got into the cranium, the Pox took possession of the poor woman's carcass, for want of a purse to release her. The pocky original Mistress &c. was proclaimed barbarous by a whole Jury of Matrons, for refusing relief to the disastored woman. In all these transactions the *Pater Familias* stood it out vigorously with a fresh countenance, no sign contradicting his pancratick health. Just such another mischance *Mass Braccada*, tells us, befell a nurse that suckled one *St. Ordo's* child, thoroughly conspurcated with the Pox. The observation hereupon infers this a *thorow-pox*, and consequently must prove infectious in all parts of the body. Physicians in this case run a great risk in feeling pulses, and approaching such Patients in their sweats.—*Venus Unmasked, or a New Exact Discovery of the Venereal Evil, or French Disease: By Gideon Harvey, London; T. Crismond, 1665. pp. 94-5-6-7-8-9.*

In like manner Daniel Turner in his work on Syphilis, published in 1717, maintains the contagious nature of constitutional Syphilis:

And this I intend shall suffice for its *Chronology* or Time, the *Topology* or Place, and the *Histriography* or Account of the Disease in general; which, with some other Writers thereon, we shall now define, *A venereal or contagious Distemper, for the most part contracted by impure Cation, at least some Contracted by the use of both Sexes, or some other lewd and filthy Diligence between each other that way tending.*

I said for the most part, because it is beyond Controversy, the Infection is also communicated by other ways, as from Pocky Parents by Inheritance; by sucking an infected Nurse, to the Child; suckling a diseased Child, to the Nurse; lying also in Bed with the Diseased, without any Carnal Familiarity; by which, though it may be possible for strong and vigorous Bodies to escape, yet are the tender ones, especially of little Infants, very likely to be contaminated, as I have more Reason to believe than by bare Imagination.

There are several other more uncommon Ways of giving as well as receiving the Venereal Venem; some of which I have already imparted to the World in short Remarks upon a Quack Libel, Printed several Years past: But the Thought of such vile Monsters, and their execrable Practices, is too shocking (unless to the Drags of humane Nature) to bear even a Repetition of Circumstances, and fit only for a detestable *Gonologia* or Collection of Smutt and Obscenity, in which I am told, they have been inserted, as some of the Author's own Observations.

As for those fancied Ways of catching it by common Conversation, drinking after one, sitting on the same Close-stool, drawing on a Glove, wiping on the Napkin or Towel, after the infected Person, with a hundred the like Stories; I believe in our time (whatever may have happened formerly) there is no great Danger: Yet we find in one of our late Chronicles, that these and such like Imaginations, were so strongly rivetted in Men's Minds at that time, even those of the better and more learned sort, that it was one of the Articles against a noted Cardinal, That he had breathed on the King, when he, the said Cardinal, had this Disease upon him

Which you will find in *Baker's Chronicle*, and of which Passage Dr. *Harvey* has also taken Notice. *Hildanus* likewise tells us of a young Gentlewoman, who contracted the same, by only putting on the Apparel of a Gentleman (that it seems was pock'd) at a Masquerade, of which, through Modesty concealing her Illness (which first of all had seized the *Padoula*) till she was past Recovery, she deceased. The good Man's Credulity, at least his Charity, might however be alms'd in this Relation, as the young Lady perhaps was also after the Masque, otherwise than by simply putting on the Habit. But were it so as the Case is stated, there is nothing therein much more admirable than what the same great Man recites of a whole Family he knew infected, viz. the Wife with three Children and a fourth in the Womb, as also a Maid Servant, by the Husband, who had got the Distemper in their Absence only by sleeping in the same bed with his Man Servant, whom he after understood was broke out with this Distemper.

The Relation of *Hers*, and *Harvamp*, are yet more strange, of several People infected in the Bagno, by having the same Scarificator apply'd after Cupping, as had been used to a Venereal Patient: Which seems a like credible with that of the Priest poked at his Ear, in the time of confessing a wanton Nun; the venomous Breath from her Mouth defiling the holy Father: But enough of this.—*Syphilis; a Practical Dissertation on the Venereal Disease: By Daniel Turner, London; R. Boscawell & Co., 1717. pp. 10-11-12.*

John Hunter, in his Treatise on the Venereal Disease, gives a number of instances of the communication of secondary Syphilis, from which we select the following:

A lady was delivered of a child on the 20th of September, 1776. The infant being weakly, and the quantity of milk in the mother's breasts abundant, it was judged proper to procure the child of a person in the neighborhood to assist in keeping the breasts in a proper state. It is worthy of remark that the lady kept her own child to the right breast, the stranger to the left. In about six weeks the nipple of the left breast began to inflame, and the glands of the axilla to swell. A few days after several small ulcers were formed about the nipple, which, spreading rapidly, soon communicated and became one ulcer, and at last the whole nipple was destroyed. The tumor in the axilla subsided, and the ulcer in the breast healed in about three months from its first appearance. On inquiry, about this time, the child of the stranger was found to be short-breathed, had the thrush, and died tabid, with many sores on different parts of the body. The patient now complained of shooting pains in different parts of the body, which were succeeded by an eruption on the arms, legs, and thigh, many of which became ulcers.

She was now put under a mercurial course, with a decoction of sarsaparilla, Mercury was tried in a variety of forms: in solution, in pills internally, and externally in the form of ointment. It could not be continued above a few days at a time, as it always brought on fever or purging, with extreme pain in the bowels. In this state she remained till March 16th, 1779, when she was delivered of another child in a diseased state. The child was committed to the care of a wet nurse, and lived about nine weeks; the cuticle peeling off in various parts, and a scabby eruption covering the whole body. The child died.

Soon after the death of the child, the nurse complained of headache and sore throat, together with ulceration of the breasts. Various remedies were given to her, but she determined to go into a public hospital, where she was salivated, and after some months she was discharged, but not cured of the disease. The bones of the nose and palate exfoliated, and in a few months she also died tabid.

Of the various remedies tried by the lady herself, none succeeded so well as sea-bathing. About the end of May she began a course of the Lisbon diet-drink, and continued it with regularity about a month, dressing the sores with lanolin, by which treatment the sores healed up; and in September she was delivered of another child, free from external marks of disease, but very sickly; and it died in the course of the month.

About a twelve month after, the sores broke out again, and, although mercurial dressings and internal medicines were given, remained for a twelve month, when they began again to heal up.

The third case was of a gentleman, where the transplanted tooth remained, without giving the least disturbance, for about a month, when the edge of the gum began to ulcerate, and the ulceration went on until the tooth dropped out. Some time after, spots appeared almost everywhere on the skin; they had not the truly venereal appearance, but were redder or more transparent, and more circumscribed. He had also a tendency to a hectic fever, such as restlessness, want of sleep, loss of appetite, and headache. After trying several things, and not finding relief, he was put under a course of mercury, and all disease disappeared according to the common course of the cure of the venereal disease, and we thought him well; but some time after the same appearances returned, with the addition of swelling in the bones of the metacarpus. He was now put under another course of mercury, more severe than the former, and in the usual time, all the symptoms again disappeared. Several months after the same eruption came out again, but not in so great a degree as before, and without any other attendant symptoms. He a third time took mercury, but it was only ten grains of corrosive sublimate in the whole, and he got quite well. The time between his first taking mercury and his being cured was a space of three years.—*The Works of John Hunter, with Notes, edited by James F. Palmer. Vol. ii., p. 475, 476; p. 484.*

In an extract from a letter to Dr. Duncan, published in the "*Medical Commentaries for the years 1783-84-85*" it is said that a new disease has lately been discovered in London, occasioned by the transplanting of teeth from the head of one person to that of another. The mortality from it is computed at nearly two deaths to ten diseases; and about one in every hundred, who receive teeth by transplantation, are affected with the disease. Ulcerations of the throat and gums, and eruptions on the skin, are the chief marks of the disease. When death takes place it is from the occurrence of sphacelus. For five or six weeks after

transplanting, the teeth look well, and are as firm as the others." pp. 490, 491.

In the third volume of the London Medical Transactions, Dr. William Watson, Vice President of the Royal Society, recorded an interesting case, illustrating the terrible effects of transplanting teeth, from which we extract the following particulars:

An unmarried lady, in the twenty-first year of her age, of a delicate habit, but in other respects in perfect health, observing one of the incisors of her upper jaw to become black and carious, determined on having it replaced by a sound tooth. This was accordingly done by an able dentist; the tooth which was introduced, being taken from the mouth of a person apparently healthy in every particular. At the end of a month, her mouth, which had continued all that time a little tender, became very painful. Her upper gums were at first inflamed and enlarged; afterwards they were discolored and ulcerated. This ulceration spread very fast, insomuch that the gums of the upper jaw were corroded away, and the alveoli left bare. Before another month was at an end, the ulceration occupied the whole space under the upper lip between the teeth and the nose; it extended likewise to the cheeks and throat, which were corroded by large, deep and fetid ulcers. Soon after this, part of the alveoli of the upper jaw became carious, one of her teeth dropped out; and in a few days a second tooth, together with the transplanted tooth, which hitherto had remained firm in its place. About this time blotches appeared on her face, neck and various parts of her body; and several of these became ulcerated sores. The fetid discharges from her mouth and throat had for a considerable time deprived her of sleep; and the soreness of the parts had prevented her from taking nourishment. And, in addition to these, the soreness from the external ulcers induced such a degree of fever that her death was soon expected.

When Dr. Watson was consulted, concluding that all her fluids were in a most putrid and acrimonious state, he directed Peruvian bark combined with gum-myrrh in large doses. No benefit resulted from this plan, and the patient was placed upon

alterative doses of mercury. The improvement was marked, the ulceration was arrested and the blotches began to disappear. The internal administration of mercury was abandoned, on account of its irritant effect upon the bowels, and the impression was kept up by rubbing mercurial ointment into her legs and thighs; this practice in like manner was attended with beneficial effects. In about ten or twelve days, the blotches had entirely disappeared and the ulcers of the mouth almost completely healed. The griping and purging, however, returned with such violence that Dr. Watson was compelled to abandon the mercury altogether. Small portions of the carious alveoli continued to exfoliate, the ulceration began again to spread, the patient labored under great weakness, with frequent returns of feverish heat, and was every night oppressed with colligative sweats. Her strength gradually lessened, till death put an end to her sufferings.

As the progress of the disease was not impeded by the most powerful antiseptics in liberal doses, and as it gave way to mercurials even in small doses, there appeared to be good ground for believing that the taint was truly venereal: but Dr. Watson, although aware of the great subtilty of the venereal poison, was perplexed by the statement that the person from whom the tooth was taken was perfectly well, and never had any venereal taint.

Mr. Clement Hamerton, Surgeon to the Castletown Dispensary, has recorded in the *Dublin Journal* (March, 1841) cases illustrating the Introduction of Syphilis into the System, through other Channels than Sexual Intercourse, from which he draws the following conclusions:

A healthy child is applied to the breast of a venereal nurse; in a couple of weeks syphilis shows itself in the child. A venereal child is applied to the breast of a healthy woman; soon afterwards she gets a syphilitic sore of the breast, which contaminates her system. A servant girl sucks a venereal sore breast, she gets a venereal ulcer of the mouth, which taints her system. The midwife has a slight scratch on the palm of the hand, and in delivering a putrid venereal child, she gets a sore on the hand which infects her system; and lastly the husband of

the midwife is diseased at the time the ulcer exists upon his wife's hand.

Dr. Egan has recorded (*Dublin Quarterly Journal*, May, 1846) several cases illustrating the contagiousness of Secondary Syphilis. In the first case the child was born apparently healthy; eight weeks afterwards syphilis appeared. An ulcer then presented itself upon the breast of the nurse, and Secondary Syphilis occurred. In the second case the child was born apparently healthy; about ten weeks afterwards a suspicious rash appeared, succeeded by blisters and fissures about the mouth; ulcers occurred on the nurse's breasts, and then a scaly eruption, and other secondary symptoms. Both cases were cured by anti-syphilitics. In the third case, the woman was a dry nurse, being disqualified by age from suckling. The child was unhealthy, and affected with sores, of a brownish color, about the nates and mouth, and a constant flow of saliva. A scratch appeared on the neck of the nurse, whether produced by a pin or torn by the nails of the child was uncertain; but being in the habit of bringing the child's mouth in contact with the affected part, in order to induce sleep, the disease was believed to be communicated through the abrasion, and the local effect was succeeded by an eruption, cured by anti-syphilitics.

In a trial which took place at Cork, Dr. O'Connor and Dr. Bull, gave evidence to show that a child affected with syphilitic eruption may convey the contagion to the nurse. (*Lancet*, July 4, 1846.)

Dr. Hector Gavin has given the history of a case, where a man and his wife, purporting never to have had syphilis, had a first child born perfectly free from any traces of the disease, subsequently to which the diseased child of a woman known to have had syphilis, but *supposed* to be cured, was placed to the wife's breast, the nipple being "cracked" at the time, and the disease was communicated.—(*Lancet*, July 18, 1846—Rankin's Abstract.)

Mr. Price of Margate has recorded the case of a woman who had syphilis, which commenced in the nipple, from nursing an infected child. She gave birth to one child affected with the disease, and to another dead child. The child from whom this

woman derived the disease had a very sore mouth and smelt very badly, and its father was known to have secondary syphilis of an aggravated character. Another respectable married woman, six weeks afterwards applied to Mr. Price, having syphilis, with a large sore on one of the nipples, and it turned out that this woman was nursing the same child which had affected the former nurse. This woman's own child also had the disease. This woman affected her husband. Two years and five months subsequently she gave birth to another child; this was affected with syphilis; twelve months subsequently another child was born similarly affected, and after this the mother was cured with iodide of potassium. Several very remarkable cases by Lallemand, Dr. King, and Dr. Maenick, will also be found in the twelfth volume of the *Medical Times*—pp. 81, 176, 422—Rankin's Abstract, Vol. 10, p. 336.

According to M. Rizzi, who had an ample field for recording facts relating to congenital syphilis, in a large hospital under his charge in the city of Milan, if a woman contracts specific ulcerations on the breast by suckling an infected infant, mucous tubercles very frequently develop themselves on the vulva and about the anus; and the syphilis, although secondary, is transmissible by contact, so that a perfectly innocent woman may communicate the disease to her husband; and it behooves the medical attendant to be well apprised of this fact, as upon his knowledge of it, not only the health, but the peace of mind and honor of the individuals must rest.

Of 100 individuals with chancres on the breast from impure lactation, or on the mouth or throat, derived from contact with an infected infant, 34 have tubercles of the vulva, 19 syphilitic angina, 3 iritis, 14 tubercles of the vulva and angina simultaneously, 5 tubercles of the vulva, and others disseminated over other parts of the body, of divers complicated symptoms, 6 tubercles of the vulva, angina, tubercles on the skin, and iritis, and 19 no secondary symptoms.

In nurses, as well as in men infected with them, M. Rizzi has remarked that tubercles are the most common form of secondary

symptoms, and angina is frequently superadded. A discharge, vegetations, and exostoses, are very rare, and buboes, when they occur, consist only of swelling and tension of the sub-maxillary or axillary glands.

In 53 infants, the disease manifested itself one month after birth in 33; at the expiration of two months in 11; of three months in 4; and in one only after the expiration of eight months. These statistics show how easily parties may be deceived as to the condition of infants that have been subject to the syphilitic poison, and how readily nurses may be exposed to the syphilitic poison from infants taken by them to nurse, without the slightest apprehension, whose parents even might not have a suspicion of the existence of the disease.—(Rankin's Abstract, Vol. v, p. 219, from *Gaz. Med. di Milano*, and *Gaz. Med. de Paris*, Oct. 24, 1846.)

On the 25th of October, 1858, a letter was addressed to the Imperial Academy of Medicine at Paris, by the Minister of Commerce, Agriculture, and Public Works, requesting an authoritative answer upon two questions: first, whether constitutional syphilis was contagious; and, secondly, whether, as regards contagion, there was a difference between constitutional syphilis as seen in infants at the breast and in adults. This letter led to the appointment of a commission consisting of MM. Velpeau, Ricord, Devergie, Depaul, and Gilbert, and these commissioners reported and their report was adopted by the Academy,—first, that some of the manifestations of secondary syphilis, especially condylomata, are undoubtedly contagious; and, secondly, that there is no reason to suppose that the case is different in infants at the breast and in adults.

The commissioners arrived at this conclusion after examining the clinical facts and experimental researches already on record, and after four experiments of their own, which were undertaken with great reluctance on their part. The persons experimented upon were all suffering from lupus, but free from any syphilitic taint, and these were chosen from the notion that the treatment for syphilis, if the inoculation took effect, might possibly be of service in remedying the lupus.

The following case will serve as an example of the four experiments.

On a man, whose face had been affected with lupus from childhood, a raw surface was made on the left arm by strong ammonia, and to this was applied a piece of lint soaked in purulent matter obtained from a condyloma near the anus of a person who had had a chancre fifteen months previously. The condyloma was of fifteen days standing. Fourteen days afterwards there was slight redness at the seat of inoculation. Four days later still, a prominent coppery-colored papule made its appearance in the same part. On the twenty-second day this papule was much larger, and there was a slight oozing from the surface. During the week following the oozing, after being purulent, dried up into a thin scab. On the twenty-ninth day a gland in the corresponding axilla became enlarged. On the fifty-fifth day, the papule on the arm had become a real tubercle, with some slight ulceration in the centre, and several blotches and coppery papules had made their appearance on the trunk. During the week following, these papules became multiplied on the body, and they spread also to the extremities; many of them also changed into pustules of acne. Two or three days later the patient was put under the treatment for Syphilis, and in six weeks, at the date of the report, there was still much to be done in the way of a cure.

In addition to asserting the contagiousness of secondary Syphilis, the commission arrived at the conclusion, that there are characteristic grounds of distinction between the primary and secondary affection, and that the period of incubation in the secondary affection is from eighteen to twenty days, or even longer, and that the result is first a papule, and then a tubercle, which is finally converted into an ulcer covered with a crust.—(Rankin's Abstract, No. 30, p. 273, from Comptes Rendus, May 24th and 31st, 1849.)

We might greatly multiply such facts from various authors, but this appears to be unnecessary, as the experience of the authors just quoted covers three centuries; and we are justified in affirming that it is now clearly established that con-

stitutional Syphilis can be transmitted by direct inoculation with the secretions of secondary sores.

And recent experiments have shown that the blood of persons affected with constitutional Syphilis is capable when inoculated on healthy subjects of giving rise to syphilitic disease.

Waller succeeded in inoculating a healthy boy fifteen years old, with this disease, by applying the blood of an individual affected with secondary Syphilis to incisions made by a scarificator on the body of the boy. Well marked and unmistakable symptoms of secondary Syphilis followed this experiment. Other experimenters have arrived at similar results, but the best conducted experiments appear to be those performed by Professor Pelizzari,* of Italy.

As this subject is of great interest, we present the account of these experiments, as it is contained in one of the most recent works on Venereal Diseases:

This physician inoculated two medical students with the blood of a syphilitic patient with a negative result. On the 6th of February, 1862, he resumed his experiments, three physicians—Drs. Bagnoni, Rodi, and Passaggi submitting themselves to his investigations. The blood of a female patient, aged twenty-five, affected with constitutional syphilis, and who had undergone no treatment, was used for the purpose. The blood was drawn, with a new lancet, from the cephalic vein. The patient was at the time affected with mucous papules on the left labium, at the place where the chancre had existed; mucous tubercles surrounded the anus, and the inguinal glands were indurated and enlarged, and there were pustules on the head. At the point on the arm from which the blood was drawn there was no sign of any eruption, the skin of the part was well washed, and the surgeon washed his own hands. The bandage was new, as was also the vessel in which the blood was received. As the blood escaped from the cephalic vein, some of it was received on a piece of lint, which was placed on the upper part of Dr. Bagnoni's arm, where the epidermis had previously been removed, and three transverse incisions made. A similar operation was performed on the other two gentlemen, but in the case of one the blood was cold, and in that of the other it had coagulated.

After twenty-four hours the dressings were removed, and nothing was observed but the crusts formed by the effused blood. Four days afterwards all traces of the inoculations had disappeared. On the morning of the third of March, Dr. Bagnoni informed Prof. Pelizzari that in the center of the inoculated surface he had noticed a slight elevation, which produced a little itching. The arm was examined, and at the point indicated Prof. Pelizzari found a small papule of a roundish form, and of a dull-red color. On the eighth day the papule had augmented to the size of a twenty-centime piece. On the eleventh day it was covered with a very thin adherent scale, which became denser, and on the second day commenced to crack in its central part. On the fourteenth day two axillary glands became enlarged to the size of nuts. The papule remained indolent, and there was no induration at its base. On the twenty-first the scale was transferred into a true crust, and the part beneath was ulcerating. Slight induration was more evident. On the twenty-second the crust was detached, leaving a funnel-shaped ulcer, with elastic and resistant borders, forming an annular induration. There was but a small amount of secretion from the

* Lectures on Syphilis, by Henry Lee, 1862; p. 198.

sore, and the pain was trifling. On the twenty-sixth the ulcer had become as large as a fifty-cent piece, and the surrounding induration was considerably increased. Up to the 4th of April the ulcer remained stationary, but at that date its base appeared to be granulating. The axillary glands remained swollen, hard, and indolent. Slight nocturnal pains occurred in the head about this time, and the posterior cervical glands became somewhat enlarged. On the 11th of April spots of an irregular form and of rose color appeared on the surface of the body. The eruption extended itself, and during the succeeding days became more confluent. No constitutional disturbance, heat of skin, or pruritus accompanied it. On the twentieth the cervical glands had increased in size and were harder. The chancre maintained its specific character and exhibited no tendency to cicatrization. On the twenty-second the color of the eruption was decidedly coppery. Small, lenticular papules were now perceived to be mixed with the erythema. The edges of the chancre had begun to granulate. Mercury was now administered.

This case is of itself sufficient to prove the inoculability of syphilis through the blood of an infected person.

III. As we have before said, in the Third Section of this Inquiry, the acceptance without reserve of the doctrine of John Hunter, expressing the impossibility of the coexistence of two actions, or two local diseases, or two different fevers, in the same part, or in the same constitution, at one and the same time, would necessarily lead to the denial of the possibility of transmitting Syphilis, through the medium of the matter produced by a distinct disease as cow-pox.

What are called pathological laws, are nothing more, than expressions of the fixed modes in which the phenomena of disease are manifested, and they conform to truth, only when they conform to, or formulate, the established course of nature. It is evident that a law may correctly express the relations of a certain class of facts and phenomena, without necessarily embracing other facts and phenomena, which upon a superficial view are related to those undoubtedly embraced by the law.

Whilst the law of Hunter may express the relations of the actions of the special poisons of the Exanthemata, (and we have shown in the third section, that it was from this very class of diseases, that the law was formulated,) it does not at all necessarily follow, that it is applicable to the actions of poisons differing wholly in their nature, mode of origin, and pathological actions.

The poison of Syphilis, after its introduction into the system, induces profound alterations in the blood, and in the processes of secretion and nutrition, and, in fact, produces derangement through all the solids and fluids. The economy under the action

of constitutional Syphilis, is to be looked upon as entirely deranged. When, therefore, another disease is engrafted upon this state, the product of that diseased action, must partake, more or less, of the diseased condition of the blood and tissues. Does any one deny this, with reference to the products of inflammation excited in the syphilitic subject? Do not even our nosologies express this fact? Where is there sufficient proof to show, that syphilitic blood and lymph, furnishing materials for the elaboration of the vaccine matter, loses, altogether during this new process, its contagious and poisonous properties in the vaccine vesicle? Is not the vaccine vesicle but the manifestation of a general disease affecting the entire system, just as the eruptive skin affection of Syphilis, is the manifestation of a disease pervading the entire system? In addition to the facts recorded in this inquiry, is it not well known that the fetus in utero is affected by the vaccination of the mother? And it is probable, though experiments are as yet wanting, that the blood of one suffering with the vaccine disease, may propagate the disease by inoculation.

If then it be possible to produce a protective vaccine pustule, in an individual suffering from secondary Syphilis, then it is established that two local and two constitutional diseases may exist at the same time and in the same constitution, and the law of Hunter falls to the ground, as far as the action of these two animal poisons is concerned.

If the law of Hunter be universally applicable, we should have no vaccine disease produced at all, upon individuals suffering with constitutional Syphilis.

But even admitting that the special contagious matter of cow-pox, formed from the blood of one suffering with constitutional Syphilis, is free from the poison of Syphilis, how can we practically, in the process of vaccination, separate this from all admixture with the diseased epithelial cells, cellular tissue, and syphilitic products of the skin and blood. If the dried scab be used, does not this cover, and in fact has it not been formed from a circumscribed portion of structure which had been originally

tainted with Syphilis, and are not its borders encrusted and mixed up with the products of the secondary diseased skin?

The truth is, that we have much yet to learn about the phenomena manifested by the living organism when acted upon simultaneously by two or more poisons. Much of our established treatment, consists in the use of certain poisons to overcome the effects of other poisons, under which the system is laboring.

In this inquiry we do not need pathological formula, and generalizations, so much as well authenticated facts.

We cannot subscribe to the doctrine, that practically all danger may be avoided, by proper caution, as "every morbid appearance on the cutaneous envelope has its own peculiar character, by which it may be distinguished from other similar phenomena, and thus the observer may easily establish a distinction between the vaccine vesicle and other vesicular, bullar, or pustular eruptions." Is it not well known that Syphilis may lurk for years in one individual, never occasioning so much inconvenience as to arouse suspicion, until it is unmasked by the unexpected appearance of an infected offspring? On the other hand how fearfully rapid and destructive is the progress of the disease in others, in which from the first appearance of the chancre, symptom follows symptom, sore throat, swelled testicle, iritis, eruptions, nodes, ulcerations, and caries, until the entire body has become apparently a mass of filth and rottenness.

Both are examples of one disease, and examples of the action of the same poison; and we can only refer these differences to the peculiar states or conditions of different individuals.

We are utterly and profoundly ignorant of the variations on the vaccine vesicle under these different states of the constitution; and we are utterly and profoundly ignorant of those conditions which are essential to the transmission of the syphilitic poison through the medium of the vaccine vesicle.

But to the facts:—

About eleven years ago a medical man was condemned to two years imprisonment for having vaccinated several children from a child exhibiting a syphilitic eruption on its face and body. The

witnesses asserted that the vaccine pustules had not been properly developed, and were followed by tedious ulcerations. Moreover, nine grown-up persons were asserted to have been re-infected by the children tainted through the vaccine pustule.

The judgment was commuted in consequence of the opinions expressed by Messrs. Heyfelder and Pauli, two distinguished medical men of Rhenish Bavaria, whose judgment had been supported by that of Ricord and Cullerier, who utterly denied the possibility of communicating the syphilitic poison by the agency of vaccine lymph.—(B. & F. Med. Chirurg. Rev., Oct., 1855, from Bull. Gén. de Thérap., July, 1855.)

M. Viennois* has collected many cases of the transmission of Syphilis by vaccination, and has summed up his conclusions from the data on hand. From his observations and researches it would appear that Syphilis cannot be communicated by vaccine virus taken from a subject affected with the disease unless a portion of the blood of the individual is also inoculated. Thus he says:

"When the vaccine virus of a syphilitic subject, pure and unmixed with blood, is inoculated on a healthy individual, a simple vaccine pustule is obtained, without any near or remote syphilitic complications being produced.

"On the contrary, if, with the vaccine virus of a syphilitic individual who either has or has not at the time constitutional accidents, a healthy person is vaccinated, and the point of the lancet be charged with a little blood at the same time as with the vaccine virus, both diseases may be transmitted by the one operation—the vaccine disease with the vaccine virus, and Syphilis with the syphilitic disease."

M. Viennois also concludes that in such cases the vaccine vesicle is developed first, and that after undergoing its incubatory period the syphilitic ulcer, with all the characteristics of a true chancre, appears.

The following are the conclusions of M. Viennois.

1. Syphilis has in many instances been observed to follow vac-

* De la Transmission de la Syphilis par la Vaccination. Archiv. Gen. de Med., Juin, Juillet, et Septembre, 1860.

cination, ever since the introduction of that operation, and by authors worthy of credit, French, English, German, Italian, &c.

2. When a syphilitic subject is vaccinated, in whom the disease is in a latent state, syphilitic symptoms may be developed by the vaccine influence; these symptoms often consist in general eruptions of a papular, vesicular, or pustular character, but a chancre never forms at the seat of the vaccinal puncture.

3. On the contrary, if a healthy subject be vaccinated with vaccine virus taken from a syphilitic subject, and the lancet be charged at the same time with a little blood, as well as vaccine matter, the two diseases may be conveyed by the same puncture—the vaccine with the vaccine matter, and Syphilis with the syphilitic blood.

4. In these cases, of which a number are on record, vaccination is first developed because its period of incubation is shortest, and its evolution more rapid than that of Syphilis. The latter appears subsequently, and manifests itself by its characteristic lesion at the inoculated spot.

5. The initial lesion, then, by which Syphilis, following the vaccinal pustule, manifests itself, is an indurated ulcer, with adenitis; in a word, all the phenomena of primitive syphilitic chancre. The great law announced by M. Rollet, that Syphilis always commences by a chancre, even when it results from secondary symptoms, or even from syphilitic blood, is thus fully confirmed.

6. After the primary chancre is developed at the inoculated spot, and in the usual period, secondary Syphilis occurs, and runs the usual course, as if transmitted in any other way.

7. When the mixture of virus does not take place accidentally, but is affected intentionally, (as practiced by MM. Spéreno and Daumès, by mixing the vaccine matter with the pus of chancre,) the result is the same; one virus does not destroy the other, but each runs its separate course.

8. The vaccine matter thus acts as a simple vehicle for the virus contained in the syphilitic blood, which it divides and dilutes, as a drop of water would do, without at all modifying its properties or its effects.

9. It is important, then, never to take the vaccine virus from a suspected person, or from an infant whose parents are unknown before the age at which hereditary Syphilis usually manifests itself.

10. If circumstances make this last necessary, great care should be taken to collect only the vaccine matter, free from blood or any syphilitic humour.

11. In no case should a healthy subject be vaccinated with matter taken from a syphilitic subject, for in spite of all precautions, there can be no certainty as to the purity of the vaccine matter.

12. These precautions are the more important, because, with the matter from one syphilitic subject a number of persons may be vaccinated, and Syphilis conveyed to nearly all, (as seen by Cerialo, of Cremona.)

13. It is sufficient to point out these precautions, to avoid new evils, and to remove the cavils of the enemies of vaccination; for in these cases, the propagation of Syphilis is not the fault of vaccination, but of the vaccinator.—(*Gaz. Méd. de Paris*, Jan. 26, 1861. *American Journal of Medical Sciences*, April, 1861.)

These views of M. Viennois have recently received the most ample confirmation from the tragedy which occurred at Rivalta, in Italy, by which forty-six children and twenty nurses had syphilis communicated to them through vaccination, and of which several of the children died. The full details of this remarkable event are given in a memoir by Dr. Pacchiotti,* of Turin, and the following summary from his report is given from Dr. Hammond's recent work.

On the 21st of May, 1861, Sig. Cagliola vaccinated Giovanni Chialbrera with lymph contained in a tube sent from Acqui. The operation was performed in the usual manner and with a perfectly clean lancet. The child was eleven months old, and in good health at the time. Forty-six other children were, ten days subsequently, vaccinated with the lymph taken from the vesicle of this child; and ten days after this, seventeen children were vaccinated with lymph taken from the arm of Luigi Mantone, one of the forty-six first vaccinated.

Of these sixty-three children, forty-six—thirty-nine of the first lot and seven of the last—were within two months attacked with Syphilis. On the 7th of October seven of them, including the little Mantone, were dead, three were yet in danger of dying, fourteen were recovering under the use of mercury and iodine, and one was well.

* *Riassunto trasmesso per mezzo della Vaccinazione in Rivalta, presso Acqui. Gazzetta della Associazione Med., Ottobre 20, 1861.*

A medical commission was now appointed to inquire into all the circumstances connected with this fatal event, and they proceeded to the execution of the duty assigned them.

Twenty-three children were examined in full; the others were not so accurately noticed, as their parents had neglected to avail themselves of medical aid in time. In the forty-six children who were affected, Syphilis appeared at periods varying from ten days to two months after vaccination, the average time being twelve days. The initiatory symptoms were variable. Sometimes just as the vaccine vesicle had healed, it became surrounded with a red, livid, and copper-colored areola, and ulcerated again. In other instances an ulcer would form on the chest, and become covered with a scab, which in a few days would fall off to make room for another, and so on. In others the vaccine vesicles had an unhealthy appearance from the first, and were accompanied by a general eruption.

The principal symptoms observed by the commission were mucous tubercles in the vicinity of the anus and on the genitalia, ulcerations of the mucous membrane of the lips and fauces, enlargement of the lymphatic glands in the groin and neck, syphilitic skin diseases, alopecia, deep tubercles, gumy tumors, etc.

In two subsequent papers, Dr. Pachiotti* continues the detail of his investigations. On the 8th of February, twenty of the mothers or nurses of the forty-six children had become affected with symptoms of Syphilis. He ascertained, too, from a revaccination of five of the children, that the occurrence of Syphilis had not destroyed the efficacy of the first vaccination. But he also discovered the source of the infection. It appeared that a year and a half previously a young unmarried woman had had Syphilis, and that she was syphilitic at the time Chialvera was vaccinated. This woman was the mother of a child which had died syphilitic three months after its birth. After the death of the child she was in the habit of having her breasts drawn by the little Chialvera, and gave him the clothes which her own child had worn. Another child nursed by this woman, but who was not vaccinated, also became syphilitic, and this child infected its mother just as little Chialvera did his mother. It is therefore shown that the vaccine virus used on Chialvera was not at fault, but that all the other forty-five children were infected through the lymph taken from his arm. It is also shown that blood was on the lancet when several of the children were vaccinated.

Dr. Pachiotti, as the results of his investigations and those of the commission, gives the following rules to be observed in vaccinating:—

- 1st. Examine the child from whom the lymph is taken.
- 2d. Inquire into the state of the parent's health.
- 3d. Take the lymph in preference from those children who have passed the fourth or fifth month, as hereditary Syphilis appears in general before that time.
- 4th. Do not use lymph taken from a vesicle which has passed its eighth day, because on the ninth and tenth days the lymph becomes mixed with pus, which latter may be of an infectious character.
- 5th. In taking the lymph, avoid hemorrhage, as there is less danger with lymph free from blood.
- 6th. Do not vaccinate too many children with the same lymph.

In consequence of the publication of the details of the lamentable affair at Rivalta, Dr. Marone concluded to relate the particulars of a similar event which occurred to him, and in regard to which he had thought it advisable to maintain a discreet silence. The particulars are given with sufficient fulness by Mr. Lee, whose excellent work I have already referred to several times.

It seems that in November, 1856, Dr. Marone obtained some vaccine lymph, with which he vaccinated a number of children at Lupara. The lymph was contained in glass tubes, and Dr. Marone noticed that it was mixed with a little blood, which affected its transparency. Of the number of children vaccinated with this lymph, notes were preserved in twenty-three cases. All these were affected with Syphilis, and the disease likewise manifested itself among the mothers, nurses, and even the servants who were brought in contact with them. The symptoms with which the children were affected consisted chiefly of eruptions of a syphilitic character, and sub-

*L'Union Médicale, Rev. Sem. et Avril Sem. 1862.

sequently of mucous tubercles at the angles of lips, around the anus, and on the vulva. The post-cervical and inguinal glands were enlarged, and there was emaciation, in degree varying with the severity of the syphilitic symptoms.

Besides these cases, eleven nurses of the number who suckled these children gave the disease to eleven other children who were not vaccinated.

In some of the cases the syphilitic phenomena continued till April, 1859.

Dr. Marone draws the following conclusions from his experience:—

“That the syphilitic virus was really transmitted in the above recorded cases by means of vaccination.

“That the children vaccinated suffered first, and became the means of transmitting the disease to others.

“That the lymph used for the purpose of vaccination was impure, being mixed with blood, and that the result shows how necessary it is to abstain from using lymph of that description.”
—*Lectures on Venereal Diseases*, by Wm. A. Hammond, M. D. Philadelphia: J. B. Lippincott & Co., 1864. pp. 206, 217.

And whilst these pages are passing through the press, we read in the Medical News and Library that Syphilis has recently been extensively propagated by vaccination in France.

In a western department of France, (Morbihan,) some villages have been the theatre of severe syphilitic symptoms in more than thirty children, who had all been vaccinated from a little girl with six punctures on each arm, the child herself having been operated upon from another who had been vaccinated from lymph preserved between two plates of glass obtained from the authorities. This misfortune created so much sensation, that the Academy of Medicine of Paris, sent down two commissioners, Messrs. Henry Rogu and Depaul. These gentlemen have just presented their report to the Academy, and this important document ends with the following considerations:

1. Several of the children whom we have examined were undoubtedly suffering from secondary Syphilis.
2. We see no way of explaining this contamination but by vaccination, and we are confident that the cases we have seen were really Syphilis engendered by vaccination.
3. As to the origin of the virus, it is very probable that the poison is traceable to the lymph, preserved between two pieces of glass, supplied by the authorities.

As primary symptoms were also observed among the children M. Ricord begged the commissioners to insert that fact in their report, which these gentlemen agreed to do. Here we unfortu-

nately have again repeated the sad occurrences which took place at Rivalta, (Italy,) a short time ago.—(Medical News and Library, 1867—from London Lancet, Dec. 15, 1866.)

The experience of the Confederate Surgeons, establishing the possibility of communicating constitutional Syphilis by vaccination; the experiments of Waller, Pelizzari and others, establishing the possibility of communicating secondary Syphilis by inoculation of the blood from patients suffering with the constitutional symptoms of this disease into healthy individuals: the cases collected by M. Viennois illustrating the transmission of Syphilis by vaccination: and the unfortunate tragedy of Rivalta in the district of Piedmont, Italy, where Syphilis was previously unknown, (forty-six children of various ages being simultaneously attacked with well-marked Syphilis, proceeding in all cases which could be properly examined from the action of vaccine virus which produced chancre on the arms, followed by buboes in the axilla, and all these children had been vaccinated directly or indirectly from a single child, who was subsequently proved to have contracted Syphilis from a wet nurse, and these children transmitted the disease to a number of women, their wet nurses and mothers, and even to children who played and nursed with them, and the women so infected, in turn infected their husbands, and finally the disease yielded in all cases to the usual remedies for Syphilis:) these, and other similar facts, as the infection of the infant at the breast with secondary Syphilis, and the communication of Syphilis from the infant inheriting the disease from its mother or father, to a healthy nurse,—all demonstrate the possibility of transmitting constitutional Syphilis by inoculation of syphilitic blood, or vaccine virus, from patients poisoned with Syphilis; and each such fact, of itself is sufficient to overthrow the dogma, that "Primary Syphilis alone is capable of being inoculated, and that secondary affections and the constitutional disease cannot be communicated from one individual to another, by any such means as vaccination, or the direct inoculation of syphilitic blood."

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APPENDIX

TO

RESEARCHES UPON SPURIOUS VACCINATION,

IN THE

CONFEDERATE ARMY,

BY

JOSEPH JONIES, M.D.,

Professor of Physiology and Pathology in the Medical Department of the University of Nashville, Tenn.

Spurious Vaccination in the Confederate Army. By JAMES BOLTON, M.D. Read before the Richmond, Virginia, Academy of Medicine, November 15, 1866.

RICHMOND, VA., Feb. 25, 1867.

JOSEPH JONES, M.D., University of Nashville:

DEAR DOCTOR: After various delays, I now send you my papers on *Spurious Vaccination* as it occurred in the Confederate Armies, only regretting that they were not forwarded at an earlier date. In addition to these, I am engaged upon some practical suggestions on Vaccination, and also upon the subject of Syphilis-Vaccination; but know not when I shall be able to furnish the papers.

Very truly yours,

JAMES BOLTON, M.D.

During the years 1863-4, a wide-spread epidemic of Small-pox broke out in the Southern States. It was impossible to supply the demand for vaccine virus. Especially was this the case in the Confederate army, which was panic-stricken by the spread of the disease. An order for virus was sent to England through the blockade. It either was never sent, or was captured. A supply was sent through the lines by the Federal authorities; but this was totally insufficient for the wants of the prisoners alone. Under orders from the Surgeon-General in Richmond, the writer was engaged in propagating virus among healthy children, and vaccinating the employes of the various departments of the Government. The reports of these vaccinations* showed that more than thirteen hundred persons, chiefly adults, had availed themselves of the powerful influence of the prophylactic agent, and that of these, only one failed to obtain perfect protection. In that single instance, the varioloid eruption appearing

* It is much to be regretted that the reports of Vaccinations in the Confederate Army, including those of *Spurious Vaccination*, were destroyed by the fire which occurred in Richmond, Va., on the night of its evacuation by the Confederate troops, and that an elaborate paper on *Spurious Vaccination*, by the writer, was wantonly destroyed by Federal soldiers.

two or three hours after the insertion of the vaccine virus, proved that the system had already become infected and that it was too late for the vaccine virus to have exercised the least protective or modifying influence. Nearly all of these persons had been previously vaccinated. It was observed that the susceptibility of the system to the virus was remarkably great. The presence of the variolous poison in the atmosphere seemed to increase the susceptibility of the system to the influence of its antidote.^{*} By a rough estimate, the writer thinks that two-thirds of the persons operated on exhibited phenomena of vaccinia, or of some grade of vaccination.[†] The same sample of virus was used upon nearly the whole of these without an unfavorable result in a single instance. Some of this virus, thus tested, was given to a Senator from Tennessee, whose physician reported, that having used the virus upon five members of the Senator's family, it produced no results in four cases, and those of a spurious character in the fifth. The youth's arm was almost covered with scabs of different thicknesses at different points, healing here and there, and breaking out again, and this succession presenting for many weeks subsequent to the vaccination. How can this be explained? This same sample of virus had been cultivated and extensively propagated by the writer for more than seven years, with none but normal results in any case. The fault was, therefore, clearly not in the virus as originally furnished. But how had this virus been preserved? It may have been kept for some time about the person, exposed to heat and moist exhalations from the surface. These circumstances, most favorable to decomposition, may have caused a putrescent state in the vaccine crust.[‡] This crust would of course produce a putrescent zymosis in the patient, or an eliminative action, or it would be successfully resisted, and then

* I have observed this on other occasions.

† Of these, two persons had been inoculated with genuine variolous matter in childhood.

‡ The vaccine crust being used almost exclusively at the South, in consequence of its retaining its properties for a longer period than the dried lymph, and furnishing a more abundant supply of virus, will be always understood as the only form of virus alluded to, unless otherwise stated.

its effects would be *nil*.^{*} Or it may be explained in another way. There may have been some occult influence, atmospheric or some other, so affecting the constitutions of these persons at the time that true vaccine zymosis was prevented or perverted. At this exigency the writer offered to supply the Medical Department with an abundance of pure vaccine virus. Having received instructions from Surgeon-General S. P. Moore,[†] he travelled for four weeks among the plantations in the interior of Virginia, vaccinating whites and negroes, and retracing his steps for the purpose of gathering the crusts. The result of this expedition was about eight hundred crusts, mostly from healthy negro children. This was distributed extensively through the army, and no further reports reached the writer of abnormal results. Among all the children vaccinated during this tour, one only presented abnormal phenomena, viz.: its face and the vaccinated arm were covered with impetigo figurata. This child was a mulatto, of a strumous appearance.

Dr. Ramsey, Medical Director at Knoxville, Tenn., reported that many cases of Spurious Vaccination having occurred at that post, a civil physician, of high repute, was employed to obtain a supply of reliable vaccine virus from healthy infants in that city and its environs. Notwithstanding the greatest care was taken, the virus thus obtained produced no effect in some instances, and in others it was followed by erysipelas and other cutaneous eruptions. Dr. Ramsey reports unpleasant abnormal exhibits recently observed to succeed the insertion of real or presumed vaccine virus. "These exhibits are not alone erysipelatous, but are in many instances a nondescript furfuraceous condition of the skin, presenting in flakes from the size of meal particles to that of a fish scale, and a much larger number of instances of rupia—sores of irregular shape and size, penetrating deep in the tissues, and thickening black scales occurring at points remote from, as well as at the point at which the real or presumed vaccine virus had been inserted. In many cases of the erysipelatous exhibits

* This I acknowledged to be entirely theoretical, as I have no facts to prove such a deterioration, and consequent zymosis ever to have taken place.

† The labors of this gentleman in the cause of suffering humanity, whether in the form of friend or foe, entitle him to a high rank in the roll of philanthropists.

sloughing of the tissues occurred to an enormous extent, even to the destruction of the part for use. * * * These exhibits have been observed in every State of the Confederacy, in every Department from the Potomac to the Mississippi. They have been observed to follow the insertion of virus obtained from different and distant geographical points. They have also been observed to follow the insertion of virus, which when inserted into other persons was followed progressively by pimple, vesicle, cellular pustule, drying, small in diameter with dark-brown or deep mahogany, but semi-opaque, color; the whole complete in from sixteen to twenty-one days, and regarded by me as regular vaccine disease. * * * These abnormal exhibits "do not depend on, or proceed from, any quality essentially pertaining to the virus which was used, but result from an epidemical cause, the impress of which is made efficient or active by the co-operation with a virus. The old doctrine of predisposing and exciting causes."

When the Army of Northern Virginia lay around Fredericksburg, after the first battle at that place, a large number of cases of Spurious Vaccination occurred among the soldiers. These appeared to be abnormal results of true vaccinations. Large numbers were sent to hospital, and many remained in a disabled condition for several weeks, the ulcers showing no disposition to heal. The army was ordered to move northward, and most of the men quitted their beds and joined the ranks. *All these cases got well on the march.* In this instance it was evident that the abnormal results were due to the condition of the systems of the men.

S. E. Habersham, Surgeon in charge of the 2nd Division of Chimborazo Hospital, reported that many cases of Spurious Vaccination occurred at that institution. In consequence of the prevalence of small-pox, orders were given by Surgeon-General Moore, to vaccinate the patients whenever the condition of their systems, impaired by disease or wounds, would admit of it. Observing that the virus, with which the hospital was supplied, produced abnormal results, a physician of high respectability residing in the neighborhood, was employed to procure genuine virus from the arms of healthy infants, for the use of the hos-

pital. The virus thus procured produced perfectly normal results in some instances, and abnormal results in others. Surgeon Habersham remarks:

"The character of all the cases which have come under my observation approximate more impetigo sparsa of an aggravated character than any other disease. The disease is evidently constitutional, as a pustule may be produced in many cases simply by the scratch of a pin in other parts of the person. I am by no means satisfied that the disease has originated from the use of *impure virus*, inasmuch as three cases were developed in this Hospital as early as December, 1862, in patients who had been vaccinated with virus which in other subjects produced a perfect vaccination with no ulterior evil consequences. It will be seen that many of the foregoing cases were developed in men who stated that they were perfectly healthy up to the time of their vaccination. My experience, however, is that in the cases developed in the hospital the patients were in bad health, and of broken down constitutions, with a very impoverished condition of blood. Under this impression vaccination was withheld from such patients until their general health had been restored, when vaccination was practiced without any evil results.

"A close inquiry into the cause and origin of the disease will reveal facts, I am inclined to believe, which will show that the predisposing cause exists in some peculiarly vitiated condition of the vital fluid and that the exciting cause is the insertion of vaccine virus."

As a strong corroborative evidence of the truth of these opinions, Dr. Habersham states that about this time a considerable supply of cod liver oil was brought in through the blockade, that a liberal supply was sent to Chimborazo Hospital, that he placed the patients suffering from spurious vaccinia upon the use of this valuable assimilative material and that they all rapidly recovered.

The following reports illustrate some forms of the disease upon which these remarks were based:

CASE X.—Private W. J. Smith, Company A, 60th Georgia Infantry, aged 22; by occupation a farmer; has suffered from an eruption of the skin for about two months; was never healthy, having suffered from debility for a long time; born of healthy parents; was vaccinated about the middle of January, 1863, in General Hospital at Danville, by Surgeon in charge. Vaccination performed in both arms, on the left first, and about ten days afterwards on the right. Both punctures produced pustules which healed in about two months, leaving dark cicatrices. He was then returned to duty. About two months afterwards a pustule formed on the upper edge of the cicatrix on the left arm. Eight pustules formed successively around the first secondary pustule, (which gradually coalesced into one scab), similar to the eruption of variola confusa.

Patient admitted into hospital May 27, 1863, presenting an eruption of five pustules on the right arm, and one near the wrist, one two inches below the bend of the elbow and three above the elbow, which were covered with thick elevated scabs

rom beneath which a sanious and ichorous pus was discharged; similar in character to impetigo sparsa. General health bad. System emaciated and anemic. Treatment—iodide of Potassium internally. General health and character of pus rules improving.

In other cases the eruption made its appearance on the lower extremities.

The following report illustrates a class of cases unaccompanied by eruption or evidence of zymosis extending to other parts of the system.

"CASE I. June, 1863: Henry H. Burnett, private, Company A, 6th Ga. Infantry, admitted May 24, 1863, with ulcer on left arm, about two inches long by one inch wide. It was very much elevated above the general surface, and upon it there was a hard, dry, black scab, which was loosely attached at the base, and from all points issued a thin, ichorous discharge. The patient's general health was bad, and he was very anemic. He states that he was vaccinated in camp on the 15th of April, by the Assistant Surgeon (does not remember name) of the 6th Ga. regiment, with virus supposed to be good; that his health was bad at the time, just convalescing from an attack of dysentery; that the third day after the operation the arm became very much inflamed from the elbow to the shoulder, which lasted about a week during which time, or soon thereafter, the ulcer extended and assumed the size and shape that it presented when admitted to hospital. The patient was put upon the iodide of potassium, gr. x three times per day, with the syrup of sarsaparilla and generous diet. The arm was poulticed until the scab came away. It presented a cupped appearance, corresponding to the elevated and fungoid base, and has all the characteristics of an indolent and chronic ulcer, which being freely cankerized improved, and the patient is now convalescent.

"The patient states that he was born of healthy parents but lost a brother with consumption: that he entered the service on the 18th of February, 1862; did not enter the service at the commencement of hostilities because of bad health, which has improved since."

During the latter part of the year 1863, and the early part of 1864 up to the fall of Richmond, the citizens suffered for the want of provisions, from the destruction of supplies by raiding parties, difficulty of transportation, and depreciation of currency. Instances of scurvy occurred among the citizens. At this time cases of Spurious vaccinia occurred, of which the following is an illustration:

"CASE II. January, 1863: Vaccinated a white woman, who resided on Third street, near the Cemetery, and on the same day her adopted child, a girl about six years old. Both were primary vaccinations and from the same virus. The vaccine

*Reported by Dr. W. H. Davis, of Richmond, Va.

disease which appeared on the child about the 5th day, went regularly through its stages. It was in fact a perfect vaccination, but in the woman it was quite different. When I examined her arm four days after the operation there was an excrescence, a spongy sore. I told her as it had failed to take I would vaccinate her from the child at the proper time. About ten days after this I was sent for to treat her arm, which presented an ulcer of an inch in diameter with incrustations from which was discharged some healthy pus. She accused me at once of having used impure virus, but the case of the child protected me. Considering the ulcer the result of some vice of system, (though I could obtain no evidence from her of this,) I treated the case with 5gr. doses of iodide of potassium and stimulants, and applied the ointment of the nitrate of mercury diluted to the part, after it had been cleansed by a flaxseed poultice. The sore proved of a very indolent character until the treatment had been used for two weeks, when it began to improve and finally healed. From her character I inferred that she had had syphilis. I vaccinated from the scab of the child without success."

It appears from the foregoing reports that in some cases the pure vaccine virus was absorbed by a system in an unhealthy condition, and produced the normal phenomena of vaccinia; but the sequelae were abnormal. In some instances latent disease appears to have been developed, in others the system had not sufficient recuperative power to restore the injured part to its former condition, and hence ill-conditioned ulcers showing no disposition to heal were left by the falling scab. In all these cases there was no abnormal contagious disease propagated by, or originating in vaccine virus.

The resulting vaccinia was perfectly protective; only the sequelae were abnormal. When the virus was used from these cases, of which the records are not numerous or clear, it produced spurious results. These phenomena appeared to be only the consequence of the resisting or eliminating efforts of the part, in order to guard the system against the introduction of an animal poison. In one instance there may have been an evanescent inflammation, and in another a true zymotic action not producing vaccinia, but an ulcer difficult to heal. In the former case the vital powers were more energetic, or the blood was in a more healthy condition; in the latter these powers were more feeble and the blood was less healthy. Both of these states were due to circumstances of nutrition, exposure, fatigue, moral condition, &c.

Beside these cases others occurred of a far more formidable

character. So great was the dread of small pox in the army, that the men became impatient of the slow process of vaccination by medical officers with carefully selected virus. Common soldiers and even officers became zealous operators. The more powerful the local action the more effectual was the protection supposed to be, and "large sores were in great request." In a short time the most terrible consequences ensued. Large numbers of men were reported unfit for duty. The attention of medical officers was called to a wide spread truly contagious disease. On careful inspection the ulcers presented the various appearances of genuine chancre. In some instances there was the elevated, cartilaginous, well cut edge surrounding the indolent, greenish ulcer: in others there was a burrowing ulcer, with ragged edge; in others there was the terribly destructive sloughing process devastating the integuments of the arm. Many of these cases were so situated that their history could be preserved, and in these secondary symptoms appeared, followed in due time by tertiary symptoms. The chancre was followed successively by axillary bubo, sore throat, and various forms of eruption, (*Syphilo dermati*), while the system fell into a state of cachexia. Finally, previous vaccination did not protect against this disease. In short, the disease was genuine Syphilis.

Whence its origin? So far as was ascertained by strict inquiry it had in no case been propagated by a medical officer. In these instances there was no case of true vaccinia followed by Syphilis. When first seen it was true Syphilis, and it never presented any other phenomena than those of this foul disease. This was true of all cases: the phenomena were those of pure Syphilis from its inoculation to its full development, on to its termination. There was, therefore, no evidence of the contamination of vaccine virus by that of Syphilis.

The results of treatment also corresponded with this view of the disease. The mercurial treatment was the only one which could be relied upon. On account of the scorbutic condition of many of the patients it was necessary to use mercury with great caution, and the alterative use of the bi-chloride of mercury was best adapted to the generality of these cases.

The question still remains, Whence the origin of this disease

in the army? It prevailed most extensively among troops from the State of Georgia, and it was thought to have been traced to a soldier from that State, who had returned home on furlough, and who was said to have vaccinated himself from his wife. It was also reported that there were many cases of this form of disease in the neighborhood of his home.

Another source of this disease was said to have been traced to the person of a highly respectable lady residing in the neighborhood of Danville, Virginia.

Finally, a third source was thought to have been traced to Culpeper county, Virginia.

All these accounts of the disease, however, are exceedingly indefinite and unreliable. In fact, they may have been given by some of the men in order to conceal the really impure origin of the disease.

The following propositions may then be fairly deduced as a resumé of the foregoing facts and remarks:

1st. That in some instances pure vaccine virus being introduced into a scorbutic system, or one deranged by some other cause, e. g., epidemic influence, an aberration of the phenomena of vaccinia was produced, but the patient was protected from variolous contagion.

2d. It is highly probable that concrete pus, or some other morbid animal product was used, and that it produced local, eliminative inflammation, with some degree of constitutional disturbance. In these instances there was of course no consequent protection.

3d. In very many cases there was true syphilitic inoculation. In these cases the virus was unmixed with that of vaccinia. Its source was purely syphilitic. Here again there was no protection.

From these propositions there result the following corollaries:

1st. Vaccinations should only be performed by educated physicians, except in case of necessity, and then by carefully instructed persons, under their observation. Vaccinations of themselves and of each other, by soldiers, should be strictly prohibited.

2d. Vaccine virus should be carefully selected from healthy

persons in whom the disease was known to have run a normal course.

3d. Except in case of necessity vaccination should not be performed when the system of the subject is in an unhealthy condition.

4th. Except in case of absolute necessity, vaccination ought not to be performed when there is an epidemic influence prevailing which predisposes to erysipelas or other congeneric diseases.

Appendix to Dr. Bolton's paper on Spurious Vaccination as it appeared in the late Confederate Army.

In a paper on Spurious Vaccination, as it occurred in the late Confederate Armies, I stated that my original paper, and the original sources of information, having been destroyed, I was compelled to write from memory, and was unable to verify my remarks by quotations. Since then I have discovered some fragments of the rough draft of my original paper, containing several abstracts of army reports. I therefore respectfully present these by way of appendix to the paper recently read before the Academy, only regretting that these abstracts are so meager.

Surgeon Habersham, in charge of the 2d division of Chimborazo Hospital, presented an elaborate report upon a large number of cases of spurious vaccinia which came under his care. He states that in obedience to an order from the Surgeon-General, he vaccinated all the soldiers as they were admitted. Instead of the usual phenomena of vaccinia, a spurious form of disease appeared, which he thus describes:

"A few days after the insertion of the virus, and in many cases within twenty-four hours, the seat of the puncture became very much inflamed, with a deep red inflammatory blush around it, which gradually implicated, in the severe cases, nearly the whole of the affected limb." A pustule rapidly formed instead of a vesicle, which soon discharged an ichorous fluid. This fluid was in the course of forty-eight hours converted into a dark mahogany-colored, irregularly-shaped phagedenic ulcer, with everted

edges, presenting the appearance of a syphilitic ulcer. There was also more or less pyrexia and loss of appetite. In these highly aggravated cases, successive crops of pustules appeared upon the upper and lower limbs, but never upon the head and trunk.

He observed three grades of the disease differing in degrees of malignancy. Thinking these results may have been due to the impurity of the virus, he cast it aside, and obtained some of a highly respectable civil practitioner, accompanied with the assurance that it had been "used in several cases with a perfect result. The introduction of this virus into the arms of some ten patients, resulted in development of the disease in question in three of them, while in the remainder it produced apparently a true pustule. From this fact, and the immunity which healthy-looking men enjoyed, I was led to believe that the predisposing cause existed in a vitiated and impoverished condition of the blood. There was no evidence to show that its origin was syphilitic."

Surgeon H. regarded the disease as a consequence of "an impoverished condition of blood, being deficient in fatty matter." Accordingly he treated his cases by supplying rich nutritious food; by the judicious use of alteratives, and by the administration of cod-liver oil. He states that a large supply of this oil was received in the early part of August, and that by the eighteenth of the same month many were well enough to rejoin their commands. The oil was used internally and locally. He arrives at the following conclusions:

1. That the disease is pustular and resembles ecthyma.
2. That it is but a local manifestation of a general disorder or vitiated condition of the blood.
3. That this vitiated condition resulted from impure and spare diet, together with inattention to cleanliness.
4. That syphilitic virus had no influence in producing the disease.
5. That the effects were not produced by any impurity in the vaccine virus.
6. That the disease can be removed by those means only which

are calculated to improve the general condition and restore the healthy play of all the functions.

W. S. Mitchell, Chief Surgeon of Rodes' Division, thus reports a spurious vaccinia which appeared in January, 1863. Inflammation occurred within twenty-four hours after inoculation. In two or three days a vesicle was formed which was soon followed by pustulation. Some observers state that the eruption was pustular from the very beginning. The ulcers were covered with thick scabs having a tendency to renewal. The ulcers were dry and many had indurated edges with little disposition to granulate and presented a tawney grey color resembling the Hunterian chancre. Two hundred and twenty-seven cases which occurred in the 44th Georgia Regiment, were derived from one man who was inoculated from his wife, in Georgia. Many similar cases were reported as having occurred in that State. Some cases yielded to, and some resisted treatment. Some were treated with mercury, and some with iodide of potash, with little advantage. The best treatment consisted in keeping the ulcers clean and applying nitrate of silver. Many cured in this way showed a tendency to return. The disease could not, have been due to constitutional vice, as the subjects were all previously healthy. It was evident that the constitution was subsequently involved, as all recovered during the Maryland and Pennsylvania campaigns. Two hundred and forty cases, left Fredericksburg, all of which recovered on the march. It was evidently not followed by constitutional symptoms. Many similar reports were made by surgeons of other divisions.

Surgeon Read, in charge of the Officers' Hospital, Richmond, Virginia, states that a number of cases came under his care which resisted treatment while at hospital, but that all recovered on being sent to their homes.

The reports of Surgeons Habersham and Read evidently refer to a class of cases not of syphilitic character. Some of Surgeon Mitchell's cases which were not fully traced out by him, may have proved syphilitic when fully developed. All those which continued to be under his observation seem not to have been syphilitic. Even this, however, is not perfectly clear. The his-

tory of the disease is certainly very suspicious. The patients were previously healthy, and the local results resembled strongly those of syphilitic inoculation. The constitution was evidently involved, but neither secondary nor tertiary symptoms were developed so long as they were under his observation, and the patients recovered without the use of what is commonly understood by anti-syphilitic treatment. These facts, however, will not be regarded by every one as conclusive, for it will not be denied that syphilis may be cured without mercury. We are not informed how long these cases continued under Surgeon Mitchell's observation, and secondary symptoms may have subsequently appeared in some of them. Without his knowledge, Surgeon Breckinridge investigated the disease as it came under his observation and carefully examined the reports of surgeons transmitted to him in compliance with orders. He concludes "that the disease was essentially syphiloid, and in respect as a whole resembled in its incipency, progress or termination the genuine vaccine disease. The army was generally in good health. There was some tendency to scurvy but no connexion could be traced between the disease and this condition. In many cases there were no evidences of a scorbutic condition. The subjects were generally in robust and vigorous health. There was no case in which I had reason to believe that any antecedent constitutional vice, either inherited or acquired, exercised the slightest influence in developing or modifying the disease. Previous vaccination failed to afford any protection against it."

Surgeon A. H. Powell's report:

A driver vaccinated a soldier from his own arm on the eighth day from the date of his own vaccination. Two or three days after there appeared at the place of the infection of the virus a suppurating ulcer, followed by large unhealthy ulcers on the arm which did not heal for six months. These ulcers were accompanied by an enlarged gland in the axilla. The soldier had two ulcers, a large one at the point of vaccination and another on the back of the hand. Several others were inoculated with the same virus and with like results. Nothing was known of its origin.

Abstract of the Report of Surgeon J. A. Etheridge:

Three hundred and thirty-two cases occurred in Dale's Brigade, beginning as early as January. Inflammation commenced within twenty-four hours after inoculation. A vesicle appeared in two or three days, but in some instances the eruption was pustular from the first. These were followed by ulcers covered with thick scabs. The ulcer closely resembled the Hunterian chancre. Two hundred and twenty-seven cases occurred in the 44th Georgia Regiment, and the virus in all these cases was derived from one man. He stated that he was vaccinated from his wife's arm while at home on furlough, and that there were other cases in the same neighborhood. All the cases in the 12th Georgia regiment were inoculated with virus derived from the 44th Georgia regiment. All cases in the 21st Georgia regiment, with few excep-

doses, were derived from the same source. The cases in the 4th Georgia regiment were derived from a scab obtained from the chief surgeon of the division.

Treatment.—Scabs were cured by the topical application of nitrate of silver, some by stimulating lotions, and others by ointments. Some were treated by the internal use of mercury and iodide of potash, but with little benefit. The best remedies seemed to be nitrate of silver locally applied, and cleanliness. In many cases there was a tendency to return.

Cause.—The disease could not have been due to an impoverished condition of the blood, as it occurred in some who had just returned from furlough, and who were in high health. Although the disease was not caused by constitutional vice, yet some such vice must have existed at the time, protracting the disease and interfering with the cure, since all recovered during the Pennsylvania and Maryland campaign. Two hundred and forty cases existed when the army left Fredericksburg, and all recovered on the march. Although he, at first, suspected it to be syphilitic, he was afterwards satisfied that it was not. No secondary symptoms occurred, and all recovered on the march. At the same time there must have been some constitutional vice, from the disease breaking out after being apparently cured.

Abstract of Report of Surgeon Hicks:

Perfectly pure virus was mixed with some whose history was unknown. This mixture produced vesicles which soon became pustular; in other instances it produced pustules from the beginning. The suppuration was so profuse that no scab was formed for two or three weeks. After several successive scabs, the ulcer healed, leaving a purple cicatrix. These sores were frequently accompanied by others upon the extremities only. There were no constitutional symptoms. In a few cases there was debility.

Treatment.—Some were treated with mercury, some with iodide of potash internally, and nitrate of silver locally; some were treated with cold water locally and generally. The cold water treatment succeeded best. Anti-syphilitic treatment failed entirely. The worst cases were sent to General Hospital, and the others went with the army. All of the latter recovered speedily. With a few exceptions, all sent to the hospital recovered, but required two or three months' longer treatment. In one case a sore above the ankle healed under the local application of bruised stramonium leaves.

Cause.—It was not scorbutic, because scurvy cannot be inoculated. The officers and men, whether they had been at home or had remained in camp, whether they used scorbutic or anti-scorbutic diet, were equally obnoxious to it. Scorbutic diet will prolong it. It does not protect the system against small-pox. It may be reproduced any number of times on the same individual no matter how advanced the sore may be. A hospital nurse insusceptible of vaccinia, was readily inoculated with this virus. It was not syphilitic, because it did not prevent the appearance of syphilis and did not yield to anti-syphilitic treatment, which served rather to prolong the disease. No secondary symptoms were observed. It resembles rubra, but this cannot be inoculated.

Abstract of Surgeon Haighill's report:

A soldier was vaccinated on the 5th of April. His arm was healed by the 1st of May, when a large ulcer appeared on one of his ankles. On the 7th of May, he complained of sore-throat, and appeared to have secondary syphilis.

Treatment.—Iodide of potash internally and lunar caustic locally. A general improvement took place under this treatment, but the ulcers had not healed on the 9th of September, more than four months after the first appearance of the disease.

Abstract of Surgeon Rutherford's Report:

In nineteen out of twenty cases the virus (lymph) was taken from the arm of a comrade by some soldier or officer, and not by a surgeon, without reference to the period after vaccination. Matter was often taken from beneath a scab. Of course this was true pus and not lymph. The only cases following the use of a scab resulting in malignant ulcer occurred in Jeffrey's Battery. The scab appeared to be derived from a secondary vaccination. From a limited experience, he concluded that the disease was due to the introduction of pus into the system.

Small-pox Epidemic in Mobile during the Winter of 1865-6. By J. C. Nott, M.D., of Mobile, Ala.

MOBILE, Dec. 12, 1866.

JOSEPH JONES, M.D., University of Nashville:—

MY DEAR SIR.—Your letter of the 5th reached me yesterday, and I regret to have to plead ignorance again on the subject in hand. I have had to treat a good many cases of Spurious Vaccination, but have no clear facts as to their origin. Many of them had syphilitic-rupial sores, &c.—they are more properly syphilitic. I am not sure but the ugly sores we saw in the army, are as anomalous as many other forms of disease which seemed to result from crowded camps and hospitals, foul air, bad diet, &c.

Dr. J. T. Gilmore, who was a medical director in the Virginia Army, saw a great deal of this Spurious Vaccine, and has promised me to write you about it. We have in Mobile a Medical Society, and it is the duty of each member in turn to read a paper once a month. Some six or eight months ago, in the performance of this duty, I threw together some rough and hasty notes on vaccination &c., which I send you in their rude state. If you can find any useful idea or suggestion, you are at liberty to use it as you like.

Very respectfully and truly yours,

J. C. NOTT.

The extraordinary prevalence of Small-pox in Mobile during the winter just passed, presenting all the characters of a true epidemic, deserves to be placed on record as a matter of history, and deserves much fuller detail than I propose at present to give it.

The reason for this extraordinary prevalence of Small-pox not only in Mobile, but more or less throughout the whole of our Southern States, is very obvious. It is now about ten months since the close of our civil war, which has thrown our population into great confusion; and the negroes having been suddenly liberated, have from various causes been congregated in the towns, and freed from their accustomed restraint and the fostering care of their former masters. A large portion of them had never been vaccinated, scarcely any vaccinated, and they therefore afforded an unprecedented amount of material for the disease. Fully nine out of ten of the deaths from Small-pox have been among the Freedmen.

The disease having been scattered by this class, through all parts of the city and surrounding country, the whole atmosphere became infected, and a true epidemic constitution established. A great many of the old citizens, both white and black, have

been attacked by Varioloid. The cases, however, among the better class, who have been in the habit of paying proper attention to re-vaccination, have been few and mild.

With regard to the protection afforded by vaccination, I must say that it is difficult to imagine a more perfect triumph than that of the immortal Jenner. My own experience leads me to declare that I have not seen more than three or four cases of varioloid among those I have been in the habit of attending and revaccinating; but I must add that I have paid no attention to age; I have re-vaccinated young children as indiscriminately as the adults and aged, and have seen no appreciable difference in their susceptibilities either to vaccine or to varioloid.

It has been evident, from the intense epidemic constitution of the atmosphere, that we should, had it not been for vaccination, had at least three-fourths of our population attacked by Small-pox. There have been treated in the Pest House alone, up to the present date, 20th March, 1866, about 600 cases. One hundred and eighty cases are now under treatment in that establishment, and there seems to be no abatement in the progress of the disease. I think that it would be within the mark to say that at least 3000 cases of Small-pox of all grades had occurred in Mobile during the last five months.

The panic produced has caused almost all of our old citizens, of all ages to seek re-vaccination, which have given some interesting results. Many adults, vaccinated in early life and exhibiting good cicatrices, have received the vaccine in a spurious form, though their systems had refused it several times previously, since the first vaccination, thus showing that when an epidemic influence is prevailing, the vaccine is much more apt to take effect in some form. This fact has been noticed by writers on the subject, and has been very striking in the prevailing epidemic. In not a few also, bearing good marks from childhood, who had repeated re-vaccinations in former years, the vaccine this year has taken perfectly and run its course regularly, as in those newly vaccinated. Such patients doubtless were in danger of taking genuine Small-pox.

How long does vaccination, when done in childhood, protect against Small-pox? Does it really wear out in a given time, or

at all? Were I to judge by my own experience, it never wears out, and time has little influence on it. If the system is once fully affected, it is good for the life time; in order, however, to be sure that the system is fully affected, it is proper to repeat the vaccination several times till the system fairly refuses good virus.

It should be remembered that when the population of a town are exposed to the influence of Small-pox, or any other epidemic disease, a considerable per centage of them are not susceptible to the disease at that time and will escape it. Members of the same family will not communicate it to those around; even children sleeping in the same bed with others sick of small-pox, may not take it. Why these immunities we know not, but yet the facts are indisputable.

So with the vaccine. Suppose you are called upon to vaccinate half-a-dozen children, and it is performed on them all at the same time and with the same virus. What happens? One may not receive it at all, in all the others it may take showing its characteristic vesicle, but affecting the individuals in various degrees, thus showing different grades of susceptibility. In one a good vesicle will appear without constitutional symptoms, in another the vesicle may be accompanied by high fever, glandular swellings &c., and the others will present intermediate grades of effect.

Now the one which did not respond at all to the vaccine virus, if exposed to small-pox might not at that time take the disease, on account of a temporary insusceptibility, but at some future day under similar exposure might be attacked by confluent small-pox. The one which took the vaccine so fully as to develop severe local and general symptoms would probably be protected for life, against either vaccine or variola. The other children which had mild local symptoms, and little or no fever, if exposed to small-pox in after life would be attacked by varioloid in various degrees, according to the degree of susceptibility left in the system. If vaccinated after one or more years, the vaccine would again show to a greater or less extent its characteristic effects on some of the cases, thus proving that the system had not been fully affected by the first vaccination, and consequently not fully protected against the poison of small-pox.

Now in the case of these six children, it must be remembered that when they were vaccinated the first time, the morbid poison was forced upon the system without any regard to its present susceptibility. The system might be disposed to reject it entirely, or to receive it in various degrees, just as when exposed to contagious diseases in the natural way. Some children during the present epidemic, could not be brought under the influence, and in one case of a healthy child of three months old, it did not take until the ninth trial.

We have no criterion, by which we can tell before hand what is to be the effect of any disease on individuals. Suppose small-pox, diphtheria, or scarlet fever appears in a boarding school, what happens? Some escape entirely, and the others are affected in all possible grades. Here you may say that the disease is again forced upon the subjects, and they receive or reject the poison in whole or in part, according to the condition of each individual. There is this great difference in the two cases. In the boarding school example, the children take the disease in the natural way, and each one may receive or reject it as the system chooses; but in the case of vaccination the poison is thrust into the blood of the subject, by the physician, without any regard to present susceptibility, and the system is compelled to fight the enemy as it best can. Under these circumstances it is rational to conclude, that in the case of vaccination, the system being forced, resists the influence of the virus to a certain extent in many instances, and thus leaves the system but partially protected, against the poison of small-pox.

Another important question arises as to the duration of the protecting influence of vaccine? Does it "wear out" in a given time, or at any time during our three score and ten? I confess that I have never seen any facts to prove that it does wear out, where the system has been once fully affected. How many hundreds of individuals does every physician see, in whom, one vaccination in childhood protects perfectly against both small-pox and vaccination through life? There are ten thousands of such cases to prove that vaccine does not wear out. My own experience, which corresponds with that of the other physicians of Mobile during the present epidemic, goes to prove that in vacci-

nation the virus just as often takes effect in children of all ages, from one year upwards, as in those vaccinated half a century previously. I have during the last few months seen scores of children bearing good marks, from the ages of one to eight or ten years, in whom the revaccinations have taken, or who have been attacked by varioloid. I have also seen scores of all ages who were insusceptible to both forms of this virus.

I have seen no evidence whatever that time has had any thing to do with the protecting influence of vaccine; but much that it depends almost entirely upon the efficiency of the first vaccination. It is, however, proper to vaccinate again and again, as we have no criterion to go by, but the repeated refusal of the system to receive it.

It has been curious to see how the epidemic constitution of the atmosphere has gradually deepened. It seems now to be breaking through all barriers. Some few have been attacked twice within three months by varioloid—many have had varioloid who have been vaccinated again and again—the vaccine has taken either well, or in spurious form, in some who had rejected re-vaccinations repeatedly before. In those who had never been vaccinated the vaccine has taken mildly and well, and the same matter has made very sore arms in those previously vaccinated.

Another interesting fact has been witnessed in attacks of small-pox in individuals while under the influence of vaccination.

Instances have been seen by our physicians in which the small-pox has broken out in subjects in all stages of vaccination, and within two or three weeks after vaccination, has run its course through. There has been no fixed rule in the conduct of the small-pox under these circumstances, and no conclusion *a priori* could be formed as to the violence of the attack. Most of the attacks of small-pox, while undergoing the influence of vaccine, assumed the form of varioloid, but some have been genuine and fatal small-pox.

It has been curious, too, to witness the infinite grades in those vaccinated. I have seen cases of varioloid with a single pustule—some with five, ten or twenty, and so on, until the disease was lost in true small-pox. Gen'l Withers had all the premonitory fever and other symptoms for four days, when a single

well marked vesicle appeared on the forearm, and ran its course with all the characteristic marks of variola.

In connection with one of the points above alluded to, viz: the power of the system to resist morbid poisons when forced upon it as is the case of vaccination, I will quote a very interesting paragraph from the "*Annuaire Encyclopedique*," for 1864.

Until recently it has been believed that the vaccine virus formed a characteristic vesicle. No matter what the diathesis or condition of the subject producing it might be, the virus was always the same, and could be used for propagation in others with impunity. In other words, that the vaccine virus in passing through a body could not be contaminated by any constitutional taint, and thus engender any other disease, such as syphilis, scrofula, &c.

"Such was the generally-received opinion," says the extract, "when it was ascertained at Rivalta, in Italy, in the first series of 46 children vaccinated the 25d May, 1861, with matter furnished by the vaccine pustules of an infant named *Chiabrova*, who seemed healthy, and in a second series of 17 children vaccinated with the pus taken from one of the children of the first, there had occurred symptoms of syphilis in 37 children of the first series, and in seven of the second series; then propagation of the infection to the mothers and to the nurses. Several of these infants died; several were fortunately cured. It was Dr. Corio who first made these facts known in France.—*Union Medicale*, t. xii."

"This caused equal surprise in France and Italy. The first impulse was to doubt. It was also the subject of very serious investigation, which left no doubt either as to the reality of this sad experience, or as to the origin of the syphilis itself. Was it necessary then to admit that two poisons so unlike could combine? On the other hand, why had a certain number of the children, both of the first and second series, escaped the infection—why had it been more powerful in some than in others? Several physicians supposed that the infection had been transmitted by the blood, which is so often mingled with the vaccine, especially when the pustules are drained to the extent which had been necessary, in order to perform such a large number of vaccinations. The discussion was long and earnest. The result a résumé of all the previous forgotten or unappreciated facts of the part touching the transmission of syphilis by vaccination, or by blood. Dr. Vennoli was the principal promoter of the opinion, which in the case of vaccination, attributed to the blood alone, the faculty of transmission. He called to mind that previously to the facts of Rivalta, he had published a memoir on this subject. Still the doubt remained, the observations were not sufficiently precise, the facts could be explained in another way. It remained to make direct experiments, as to the possibility of syphilitic infection, by a minute quantity of the sanguine fluid. This direct experiment was made at Florence by Dr. Pellizari, on Medical Students who volunteered for the purpose. He proved that a few drops of blood are sufficient to transmit syphilis. Thus it has been demonstrated that, to explain the facts, it is necessary to admit the mixture or composition of the two poisons, which upset all previous notions. It is also demonstrated that the fresh sanguine particles, borne on the vaccinating lancet, at the same time with the vaccine, may transmit the syphilitic infection. From these facts it results

that in future we should inquire with great care into the previous history of those children from whom we select our protecting virus."

Now gentlemen, these facts are set forth with a fullness of detail and a weight of authority that challenge belief, and if borne out by future investigations are of immense practical value. In the present stage of the question it is our duty to take the benefit of every doubt and use the utmost precaution in selecting the virus we employ, and in removing it from the arm from which it is selected without its being contaminated by a particle of blood. There is, I think, another important point to be attended to, and it is this. When we vaccinate, the lancet always draws more or less blood. Not only should the lancet be thoroughly cleansed before it is used on another subject, but the identical matter should not be used on a second subject. We ordinarily mix the dry scab in this country with water on a piece of glass, and in the process of vaccinating a child, the lancet is dipped several times into the mixture, thus necessarily adding to it some particles of blood. In this state another piece of glass is ordinarily placed over the one on which a part of the virus just used remains, and is carried about in the pocket for a day or two, or more, to be remoistened and used again on others. Now to my mind there are two strong objections to this method. 1st. The virus is thus contaminated with blood. 2nd. From being kept in this moist state it becomes putrid, and not only fails to produce a good vesicle in succeeding subjects, but may hazard, from its putridity, the production of spurious vaccine, followed by bad sores and even symptoms not unlike dissection wounds. I throw these hints out for further investigation.

I beg leave to add to the above an extract translated from the "*Annuaire de Medecine et de Chirurgie*," 1864, which will be found interesting in connection with the above, at this time.

"SYPHILITIC VACCINE AND THE MEANS OF PREVENTING IT."

"The contagiousness of the blood plasma being demonstrated to his satisfaction, as to the congenital contamination of the infant by the mother, M. Laroynne, admits in like manner the contagiousness of the serum that transudes under the vaccine pustule, and mingles with the vaccine without the possibility of being distinguished. Hence a new danger outside of the blood, and the vaccinal chancre, which

cannot be avoided, except by most scrupulous examination of the subject from which it is taken, and of the mother if it is not too old. The subject vaccinated, itself should not be overlooked, for it may also be a source of infection, according to the same author. In a collection of children to be vaccinated, if there be one infected, a common lancet, impregnated with his blood may communicate syphilis to all those vaccinated after him, and to the subject from which the vaccine is taken. (*Gaz. de Lyon*, N^o 12.) All this is possible without doubt, but is not demonstrable, and is not even probable, for if the syphilis had so many chances of being communicated so easily by vaccination, would it not be more frequent?

Without deciding on this accessory question, M. Dupaul, in making this important subject, the principal object of his annual report on vaccine to the Academy of Medicine, has recognized the reality of the transmission of syphilis by vaccination. Doubtless a discussion will clear up the points in dispute."

"*Vaccine-bearing Heifers*.—There exists in Naples, says M. Palasciano, besides the official vaccine institute for vaccinating from arm to arm, an establishment of Dr. Galbiate, where the cow-pox is propagated through heifers, in sufficient number to supply many vaccinations. When it is wished to have a child vaccinated, one of these heifers is driven to the door, the conductor cuts out a pustule entire with a pair of scissors and hands it with a pair of forceps to the physician who executes the vaccination. The whole costs one dollar. This plan is also used in the army and colleges, and vaccination from arm to arm is practiced little except among the poor."—*Congrès de Lyon*.

It is desirable that similar establishments should be founded in France, as it would be the surest means of escaping syphilitic vaccine.—*Union Méd. de la Seine Inf.*, p. 193.

M. Lanoix, who went to Naples to study this mode of animal vaccination, has tested it successfully and publicly at Lyons. He vaccinated a heifer of nine months old, in the iliac region and at the proper time transferred the matter to the arms of children. But we must not pass over another curious extract, which is as follows:

The milk of cows, submitted to this inoculation, would, according to Dr. Scobie of Leghorn, have another advantage. By drinking the milk during the course of the inoculation, all the benefits of vaccination are obtained. He inserted the vaccine into the teat of a cow, and two fine pustules being developed, he made two children drink the milk. One, six months old nourished by the bottle, took 600 grammes in two days, the fifth and sixth of the vaccine; the other aged fourteen months, weaned, drank only half this quantity on the eighth day of the vaccine. A month after, having attempted to vaccinate them from an arm, they refused it, while the same matter succeeded perfectly in another inoculated at the same time."

These statements, to say the least, are interesting, and, coming from sources of high respectability, demand examination.

FACTS ILLUSTRATING THE PROPAGATION OF ERYSIPELAS BY CONTAGION.

In the Sixth Section, of my "RESEARCHES UPON SPURIOUS VACCINATION," it was said that "it can be shown, that the evidence of contagion in Erysipelas rests upon nearly the same grounds as in the well known contagious diseases, scarlet fever, measles, and typhus fever."

One object sought by this discussion of the relations of Erysipelas to Vaccination, was the establishment of the practical rules, that "Vaccine matter obtained from the arms of fields and often scrofulous convalescents of crowded civil and military hospitals, is wholly unfit for the propagation of the vaccine disease; the quality of the vaccine virus, will depend in great measure upon the manner in which the nutrition of the body is performed: of all places, civil and military Hospitals are the very last to which the profession should look for supplies of vaccine matter."

"As far as possible, soldiers especially during long and fatiguing campaigns, and when crowded in hospitals and barracks, should be vaccinated with the lymph or vaccine virus from young healthy children."

"It is here, both in Civil and in Military practice, not to use the vaccine virus from the arms of soldiers, because their mode of life is an artificial one, to a great extent: a stereotyped life of restraint and hardship, and of great monotony of diet, and consequently a life liable to great excesses and irregularities of habits, and to great and sudden variations of health, as well as to slow and imperceptible deterioration of the nutritive fluids."

In the brief discussion, it was freely admitted that Erysipelas at times prevails as an epidemic, and appears to be produced by some general epidemic influence, and that in many cases the disease may be most plausibly accounted for, by sudden changes of atmospheric temperature along with considerable moisture, together with derangement of the bowels, and the effects of particular articles of food, ardent spirits, and vicious habits: and that isolated cases frequently occur in private families and even in hospitals, in which the disease, as is often the case with Typhus Fever, Typhoid Fever, Hospital Gangrene, Pyæmia and Asiatic Cholera, spreads no further.

The rapid propagation of Erysipelas both in the sick room and in the wards of the hospital, has been so frequently observed, that no doubt can exist of this disease being under certain circumstances communicated by emanations, by fomites, or by some palpable virus. The adoption of this proposition, does not at all overthrow the belief which we also hold, that the origin and spread of Erysipelas in Hospitals, and in private families, will depend upon the hygienic condition of the wards and rooms, and upon the state of the constitution of the patients.

It is the intention of this brief note, to detail facts rather than to enter into any hypothetical discussion.

In the summer of 1793, a person laboring under erysipelas of the face was brought into St. Thomas Hospital in London, where he died. Another patient having a different disease, was put into the same bed before it was duly purified. This patient was shortly after seized with erysipelas of the face.

Several other persons in the hospital were then attacked, among whom was an upper nurse, or sister, and she died. A rumor hence arose that the plague had got into the hospital; and so widely did this opinion spread, that an advertisement was inserted into the newspapers of the day, contradicting the rumor. Dr. Baillie de-

scribed it as spreading also in St. George Hospital, London, and Dr. Cullen, in the Hospital at Edinburgh. Dr. Wells has brought together several examples in which the complaint appeared to be unequivocally propagated by contagion.

"I visited," says Dr. Wells, "on the 8th of August, 1798, in Vine Street, Clerkenwell, an elderly man, named Skelton, who had been attacked several days before with erysipelas of the face. It was about a week afterwards he died. On the 16th of the following month, I saw Mrs. Dyke, of about seventy years of age, the landlady of the house in which Skelton had been a lodger, and found her labouring under an erysipelas of her face. I inquired whether any other person in her house had been ill of the same disease since the death of Skelton, and was told that his wife had been seized with it a few days after his decease, and had died in about a week. During my attendance upon Mrs. Dyke, an old woman, her nurse, was attacked with the same disorder, and was sent to her parish workhouse, where she died. Mrs. Dyke has since informed me that a shortly after visiting him, and survived the attack only a few days. That she herself had been several times with Skelton, and his wife during their sickness, and after their death had removed some furniture from the room they had occupied to her own apartment.—*Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge.*

Dr. Wells relates other histories of the same kind, which in like manner occurred when there was no epidemic of Erysipelas prevailing.

Dr. Pitcairn attended, in February, 1797, a lady with child-bed fever, who had erysipelous inflammation in her skin. Her new-born babe had erysipelas of the puerperium, and both mother and child died after a few days' illness. Eight days after the death of the child, the lady's mother and a servant maid, both of whom had attended the child in its illness, were attacked with erysipelas faciei, from which both recovered.

Dr. Stevenson details briefly the results of twenty-one cases of erysipelas which occurred in his practice in 1821-2:

"It spread in many instances, through the members of the same family; in some it appeared soon after visiting friends, or relatives during the period of the disease. A person who was attacked while in attendance on an erysipelous patient went home to her parents, who resided at some distance, as soon as she was taken ill; they were soon successively seized, and the mother died in a few days."—*Transactions of the Medical Chirurgical Society of Edinburgh*, vol. ii.

Dr. Gibson has recorded similar cases which came under his observation in 1822. (*Trans. Med. Chir. Soc. of Ed.*, vol. iii.)

"A young man with erysipelas of the face, was brought to his father's house at the distance of some miles. He ultimately recovered. His master had died a few days before of a febrile disease, spread to the face. He died in a few days. The father of this young man was attacked with erysipelas in both hands and arms, which who resided the child, was seized with erysipelas of the scalp. The nurse, who resided the child, was seized with erysipelas of the face and scalp, and died soon afterwards. A sister living in the same cottage, had fever with sore throat, from which she slowly recovered. Two children in the same house were cut off with what appeared to be the same. The disease in the sister and children was supposed to be erysipelous inflammation of the fauces and trachea.

A woman was admitted into the infirmary of Montrose, with suppuration of the hand, which had followed an attack of erysipelas. Some days after her admission, the patients in the two beds next to her were seized with erysipelas. It was afterwards found that, notwithstanding all the patients were removed from that ward, and the process of cleansing, whitewashing and fumigating adopted, the disease again reappeared when fresh patients were placed in this ward, so that it became at length necessary to shut up the infirmary for a time.—*Cyclopedia of Practical Medicine*, Art. Erysipelas.

Mr. Lawrence also mentions similar cases. (*Medico-Chirurgical Transactions of London*, vol. xiv.)

Dr. George Gregory, in his valuable lectures on the Eruptive Fevers, has expressed his belief in the contagious nature of Erysipelas in no unequivocal terms, and his views are worthy of careful consideration in this connection.

"A connection of more than twenty years with the Small-Pox Hospital, has given me abundant opportunities, not only of confirming the truth of these propositions, but of showing that we may carry our views much further. I feel persuaded, first, that Erysipelas may commence in no hospital without the exception of importation. 2. That being so generated, from bed to bed, it may spread by contagion. 3. That the miasm generating erysipelas is identical with that which

in lying in hospitals generates puerperal peritonitis, which in foundling hospitals and workhouse nurseries gives rise to puerperal gangrene and umbilical ulceration—which in army hospitals generates hospital gangrene—which in hospitals differently circumstanced is found to occasion a malignant form of erysipelas, both mucous and cellular, with cutis, glossitis, an aethetic form of lymphitis, the most aggravated type of typhus gastritis.

"The origin of scurvy in crowded and ill-regulated ships, is obviously a branch of the same general doctrine. A destructive miasm is there generated which is far more malignant in the human frame, than the use of salt provisions. Whatever be the exact nature (or causes) of the miasm which thus generates erysipelas, peritonitis, gangrenous ulceration, or scorbatic blotches, it is something depressing to the vital power.

"The dependence of erysipelas on a miasm *res gestae* is no new doctrine. It has been stated there with the importance which it merits; nor has the doctrine been received as one of the sacred axioms of pathology. Dr. Rollo, in a treatise entitled, 'A Short Account of a Malignant Poison, Acting on Rome,' and published very early in this century, distinctly announces the principle, and illustrates the intimate connection between erysipelas and hospital gangrene.

The circumstances which lead to the development of oedematous miasm have never been investigated with all the accuracy which is desirable, and of which the subject is certainly susceptible. The first in importance is undoubtedly overcrowding the wards of an hospital. When the French and Swiss (I think it was early in the French Revolution,) were labouring diligently to reform the abuses in the Hotel Dieu, some of them were at the pains to calculate in how many hours, supposing the ward to have been hermetically sealed, all the patients in it must necessarily have died, presuming that each adult requires for his support a gallon of air per minute. The time was wonderfully short.

2. But it is not numbers alone which are to be considered. A ward might safely hold fifty cases of simple fracture, which would not with safety contain twenty cases of compound fracture. Something, therefore, depends on the nature of the disorder. All disorders which throw out diseased secretions are more apt to taint and vitiate the air, than those where no such seeping process goes forward. It is on this account that the wards of the Small-pox Hospital are so peculiarly liable to generate oedematous miasm.

3. Another element of great importance in determining the sources of oedematous miasm is the degree of attention bestowed on cleanliness. If the bed linen, mattresses, palliasses, sheets, and blankets, be frequently changed, the floors well cleaned, and the walls frequently whitewashed; if the nurses be careful to carry away all foul secretions, and to purify the patient's body by abundance of soap and water; in short, if the internal regulation of the hospital be good, miasm would, I suppose, be rarely engendered, even though the ward were crowded.

4. A fourth element must enter into the calculation, and that is a good supply of fresh air. This by some is considered all in all; but it is not so, and all the ventilation in the world, conducted on the most scientific principles, and superintended by Dr. Reid himself, would fail in preventing oedematous miasm, if feather beds or bolsters, soaked in unhealthy discharges, are permitted to remain in the ward.

5. Dr. Rollo has advanced a step further in the analysis of oedematous miasm, and maintains that the disposition to erysipelas and its correlative diseases (puerperal peritonitis, and hospital gangrene) depends partly on a peculiar, but hitherto undetected condition of the atmosphere. He is led to this opinion by observing that erysipelas sometimes shows itself in the airiest, best crowded, and best regulated hospitals. Without stopping to inquire how much is due to this circumstance, we are fully warranted in saying that the state of the atmosphere must not be lost sight of in such an investigation. We know on the authority of Dr. Litch, that in Batavia and other localities notorious for malaria, hospital gangrene and erysipelas, and every sort of associated disorder, prevail with intensity at certain seasons.

Assuming it as proved, that erysipelas is liable, from one or more of the five causes now detailed (viz. accumulation of persons, character of the discharges, want of cleanliness, want of ventilation, constitution of the atmosphere), to spread epidemically, it is still to be shown that this disease throws off contagious emanations, which can, *per se*, independent of any such influences, propagate the like complaint.

"Dr. Wells has met this question fairly by detailing a variety of cases where erysipelas spread by contagion in private houses, and under circumstances calculated to exclude all agency save that of simple contagion."

Dr. Gregory supports his views by a reference to the cases of Dr. Wells, Pitcairn and others, and also by his own individual experience.

Dr. Elliottson, in his "Principles and Practice of Medicine," gives the following account of the mode in which he contracted the disease in his own person.

"I recollect once having had it, five days after stopping down over a patient, who had the disease in so violent a form that he died of it. I was looking into the state of his skin; and his breath came into my face. I turned away with a feeling of disgust; and said, 'I hope I have not caught it.' But, five days afterwards, having forgotten the circumstance, I was seized with erysipelas. I felt chilly, and my head was sore; and I had the disease violently."

Professor Arnott also has given striking examples of the propagation of erysipelas from one person to another, not only under the same roof, and in the same locality, but also when the parties lived at a distance from each other, and the intercourse had been but for short periods of time.

Dr. Thomas Watson, who advocated the view that Erysipelas is contagious, gives the following incident in his "Lectures on the Principles and Practice of Physic" which had been told him upon good authority.

"A man living somewhere in Westminster fell ill of despicable erysipelas. In that state, for some reason or other, he was removed thence; and his brother, who was a servant in or near Portland Place, received him clandestinely into his master's house, and allowed him (for two nights, I believe to share his bed). That brother was soon attacked with erysipelas; and in the course of his illness was visited by his master. The master was also attacked; and it is worthy of remark, that in both master and servant, the disease showed itself just seven days after they had respectively come near another who was affected with it."

Dr. Rogers has related a case, which closely resembles that of Dr. Elliottson:

"A medical student went into the country, and was requested by his brother, a medical man, to visit an erysipelous patient. Whilst leaning over him, he became conscious of a muscous odor, which almost caused him to be sick. A few days after, he was suddenly seized with shivering, followed by fever; erysipelas shortly came on in the head and face, and he died after a week's illness."

In the following instance, communicated to Dr. Campbell De Morgan, Surgeon to the Middlesex Hospital, by Dr. Goodfellow, it is evident that the disease spread from bed to bed.

"In the epidemic of Typhus that prevailed in the autumn of 1838, more or less of erysipelas was constantly to be found in the wards; and, as a general rule, it spread from bed to bed. On one occasion, however, this was more than usually striking. It occurred in the large fever ward, containing thirteen beds, and well ventilated. Erysipelas attacked a patient on that side on which were seven beds. She was in the bed next but one to the end; the patient lying in the next bed, the third from the end, was next attacked, and then the patient at the end. The disease successively attacked all the patients in the order in which the beds were placed, until it reached the lower end of the ward. It then attacked the patient lying at the same end of the ward, but on the opposite side, and spread from bed to bed until it reached the last on this side, the patient lying in which was the only one who escaped."—*A System of Surgery by various Authors, Edited by Holmes, pp. 247-8.*

Dr. Steele, in his Annual Report on Guy's Hospital for 1863, writes, that "for some years past it has been customary to place patients suffering from erysipelous wounds in these (the medical) wards, in order to diminish as much as possible the risk of extending infection in surgical wards, as well as to promote recovery in the patients themselves. It happened, however, that in one of the wards of the new hospital into which a patient suffering from erysipelas was placed, in the course of the past year, *several* persons suffering from other complaints were attacked with the disease; and although none of the cases were attended with fatal consequences, the occurrence is sufficient to point out the danger which must be occasionally apprehended."

Erysipelas has spread extensively, and for long periods, in the Birmingham, Edinburgh, Glasgow, and London hospitals and it has been frequently necessary to empty and whitewash the wards and thus rid them of the disease.

Many of the Surgeons of the English Navy believe in the contagiousness of Erysipelas; and it has been debated, whether scrubbing the decks, or dry rubbing them is the best mode of cleansing a ship and preventing the spread of the disease.

The old Dreadnought, hospital in the Thames is said to have been so impregnated with the contagious matter of Erysipelas, that she had ultimately to be broken up, and a new vessel substituted.

JOSEPH JONES.

LITTLEMORE ASYLUM.

SUPERINTENDENT'S REPORT

FOR

1865

WITH

STATISTICAL TABLES.

COMMITTEE OF VISITORS FOR 1866.

HUGH HAMERSLEY Esquire, *Chairman*,
The Right Honorable JOSEPH WARNER
HENLEY M.P.
ROBERT BULLOCK MARSHAM Esq.D.C.L.
The Reverend PHILIP WYNTER D.D.
JOHN HENRY ASHHURST Esquire
The Reverend RICHARD PRETYMAN
CHARLES EDWARD THORNHILL Esquire
JOSEPH JOHN HENLEY Esquire
ARTHUR HENRY CLERKE BROWN Esquire
GUY THOMSON Esquire
Captain JOHN AUGUSTUS FANE
GEORGE GAMMIE-MAITLAND Esquire
HOLFORD COTTON RISLEY Esquire
HENRY BARNETT Esquire M.P.

Justices
of
Oxfordshire.

JOHN HARLOCK Esquire
HENRY WARD Esquire

Justices of
the Borough
of Banbury
(part of
Oxfordshire).

George

GEORGE CHARLES CHERRY Esquire, *Vice-Chairman,*

THOMAS LEINSTER GOODLAKE Esquire
LT. COLONEL ROBERT LOYD-LINDSAY
V.C. M.P.

RICHARD BENYON Esquire M.P.

JOHN WALTER Esquire

JOHN SAMUEL BOWLES Esquire

JOHN BASIL BARRETT Esquire

RICHARD TULL Esquire

EDWARD HENRY MORLAND Esquire

WILLIAM GEORGE MOUNT Esquire

DANIEL BENNETT Esquire

JOHN BLANDY-JENKINS Esquire

HENRY TUCKER Esquire

Justices
of
Berkshire.

ROBERT BLUNT Esquire
WILLIAM HANSON Esquire

Justices of
the Borough
of Windsor
(part of
Berkshire).

WILLIAM THORP Esquire
RICHARD JAMES SPIERS Esquire
WILLIAM WARD Esquire
ISAAC GRUBB Esquire

Justices of
the City
of Oxford.

JOHN HYDE Esquire
CHARLES PAYNE Esquire
RICHARD BADCOCK Esquire

Justices of
the Borough
of Abingdon.

EDWARD BLACKWELL Esquire
CHARLES JAMES BUTLER Esquire
WILLIAM SILVER DARTER Esquire
and
TIMOTHY LORKIN WALFORD Esquire

Justices of
the Borough
of Reading.

Officers.

OFFICERS.

*Mr. WILLIAM LEY, Surgeon, *Superintendent.*

*The Rev. EDWIN WILLIAM RELHAN
PULLING, *Chaplain.*

HENRY WENTWORTH ACLAND M.D.,
Consulting Physician.

Mr. EDWARD LAW HUSSEY, *Consulting Surgeon.*

*Mr. RICHARD HENRY HEURTLEY SANKEY,
Clinical Assistant.

Mr. GORDEN DAYMAN, Oxford, *Treasurer.*

Mr. BROMLEY CHALLENGER, Abingdon, *Auditor.*

Mr. JOHN MARRIOTT DAVENPORT, Oxford,
Clerk of the Visitors.

Mr. JOSEPH JOHN ANDREWS, *House Steward
and Clerk of the Asylum.*

*Mrs. ROBERTS, *Housekeeper.*

*The Officers thus marked are resident.

LITTLEMORE ASYLUM

[*comprising an Union of the Counties of Oxford
and Berks, the City of Oxford, and the Boroughs
of Abingdon and Reading for the maintenance of
their Pauper Lunatics*].

At the first Meeting of the Committee of
Visitors of the PAUPER LUNATIC ASYLUM
at LITTLEMORE appointed for the Year
1866, held at the Asylum (pursuant to due
notice) on Wednesday the 31st day of
January 1866 (being within one Calendar
month after the election of the present
Committee),—

PRESENT

HUGH HAMERSLEY Esquire, *Chairman,*
The Right Honorable JOSEPH WARNER
HENLEY M.P.

JOHN HENRY ASHHURST Esquire
CHARLES EDWARD THORNHILL Esquire

HENRY BARNETT Esquire M.P.

GUY THOMSON Esquire

JOSEPH JOHN HENLEY Esquire

GEORGE GAMMIE-MAITLAND Esquire

Captain

CAPTAIN JOHN AUGUSTUS FANE
ARTHUR HENRY CLERKE BROWN Esquire,

Justices of Oxfordshire;

GEORGE CHARLES CHERRY Esquire
THOMAS LEINSTER GOODLAKE Esquire
JOHN WALTER Esquire
RICHARD BENYON Esquire M.P.,
WILLIAM GEORGE MOUNT Esquire
RICHARD TULL Esquire
DANIEL BENNETT Esquire
EDWARD HENRY MORLAND Esquire
HENRY TUCKER Esquire,

Justices of Berkshire;

WILLIAM THORP Esquire
RICHARD JAMES SPIERS Esquire
WILLIAM WARD Esquire
ISAAC GRUBB Esquire,

Justices of the City of Oxford;

JOHN HYDE Esquire
RICHARD BADCOCK Esquire,

Justices of the Borough of Abingdon;

The Mayor of Reading (EDWARD BLACKWELL Esquire)

and

TIMOTHY LORKIN WALFORD Esquire

Justices of the Borough of Reading.

Resolved that the following

REPORT*

of the SUPERINTENDENT be printed and circulated.

TO THE COMMITTEE OF VISITORS.

GENTLEMEN

At the opening of the year 1865 negotiations had been commenced with the Visitors of the DORSETSHIRE Asylum at CHARMINSTER, for the transfer, to their temporary charge, of a certain number of Lunatic Male Patients for whom the LITTLEMORE Asylum had not sufficient accommodation; especially as it was threatened with an increased number of Inmates,

* Rule 25—[of the General Rules of the Asylum.] The Superintendent shall submit to the Committee of Visitors, at their first meeting after the Epiphany Quarter Sessions annually, a Report in writing, of the general condition of the Asylum, and the number and character of the Patients; distinguishing the numbers who have been received and discharged as cured; the number of re-admissions; the number employed, and in what manner; the deaths which have occurred in the preceding year, and also the total number of discharges, cures, and deaths since the opening of the Institution, and specifying the sexes in each statement; with such other facts as the Superintendent may think desirable, or which the Visitors may have suggested.

in Patients recently attacked, as well as by the return of Patients who had been sent (under contract) to the BUCKINGHAMSHIRE Asylum at STONE.

The Visitors of the two Asylums (LITTLEMORE and CHARMINSTER) at once agreed upon terms, taking,—as the basis,—the Contract already subsisting between LITTLEMORE and the WORCESTERSHIRE Asylum at POWICK.

The Contract with CHARMINSTER however, could not be completed until sanctioned by the Secretary of State; and, pending the correspondence with him, an extension of the number of Patients proposed to be sent to CHARMINSTER, was agreed upon. This number embraced the LITTLEMORE Patients then, under contract, at the Licensed House at BETHNAL GREEN;—the Visitors considering it to be more consistent with their duty that all the Lunatic Patients under their charge should be in

County Asylums (under the care of cognate bodies of Visitors) than at BETHNAL GREEN or any similar Establishment,—however well conducted.

The Patients at BETHNAL HOUSE had from time to time been visited by Members of the LITTLEMORE Committee, as well as by Officers of that Asylum, and their care and condition were always favorably reported of. And, before removing the Patients from BETHNAL, an expression of the satisfaction of the LITTLEMORE Visitors at the care and treatment of the Patients, was officially conveyed to Dr. Millar, the Superintendent.

The Contract with CHARMINSTER being completed, the Patients were removed thither, by Railway, (partly from LITTLEMORE, and partly from BETHNAL HOUSE) in July and September last; and that without any untoward circumstance occurring.—The number so removed was 60; (of

whom 35 were Male and 25 Female Patients). In addition to this number at CHARMINSTER, there are still 7 Male Patients at the BUCKINGHAMSHIRE, and 30 Female Patients at the WORCESTERSHIRE Asylum.

Reports of the condition of all of them have recently been received; and they have all been seen by Officers of the LITTLE-MORE Asylum within the last year. It is probable that the remaining Patients at STONE Asylum will be returned to LITTLE-MORE in the ensuing Spring.

The number of Patients received at LITTLE-MORE during the year 1865, has been 131; namely 69 Males, and 62 Females. This is a smaller number than usual; the diminution being principally in respect of Female Patients, and in the first quarter of the year.

The re-admission of Patients in the year, amounted to 20 in number; 3 of

them being Men, and 6 Women received back within twelve months of their previous discharge as cured; whilst the remainder (6 Men and 5 Women) had been away for longer periods.

The discharges in the year have consisted of 24 Men and 32 Women, recovered; 5 Men and 3 Women discharged for other causes: (being a total of 64), exclusive of a Criminal Patient whose name was, by order of the Secretary of State, taken off the books, after being absent from the Asylum, (by escaping), for some years.

The number of Deaths in the Asylum during the year was unusually small.—The deaths of 18 Men (out of 309 who were under charge in the year), and of 27 Women (out of 370), present a favorable report of the mortality in the year.

Throughout the year there was ample accommodation in the Female Wings for

the number of Female Patients, and for any small number likely to be received.

There were 255 Female Patients in the LITTLEMORE Asylum on the 1st of January 1865, and 253 on the 31st of December. The average daily number in the year was 247; being about the number for which those Wings were provided.

As regards the Male Wings it was otherwise; for there were on the 1st of January 224 Male Patients; but, previously to the removal of Patients to the CHARMINSTER Asylum in July, the number had reached 236. They were however, reduced by that transfer to 207. The Wards had been unusually free from sickness and continued to be so. On the 31st of December the number of Males again reached 220.—The average daily number in the year was 219.

The total number of Patients at LITTLEMORE on the 31st of December was 466; of whom 219 were Males, and 247 Females.

There was, during the year, an increase of 22 Men in the whole number of Patients under the charge of the Visitors.

That number may be thus summarised:

	Males	Females	Total
In the LITTLEMORE Asylum	220	253	473
" " STONE Asylum	7	—	7
" " POWICK Asylum	—	30	30
" " CHARMINSTER Asylum	35	25	60
Total	262	308	570

The CORONER of the District (WILLIAM BRUNNER Esquire) held the following Inquests during the year. 1. Upon the Body of a Female who died under Epilepsy. The circumstances evoked no comment. 2. Upon the Body of a Male Patient, who died by an act of Suicide, the cutting of his Throat. The Verdict of the Jury was that he committed suicide, being at the time of unsound mind. The CORONER, on this latter occasion,

addressed a Letter to the Visitors, which was read at the following Monthly Meeting of the Committee, calling attention to the damage, by wear, of the locks of the Asylum; and to the fact that the doors were so shrunk, and so much withdrawn from the jamb of each doorway, that the bolts of the locks could be easily forced back. A party of Visitors examined the door and lock which were especially referred to, and conferred with the Committee upon it. The subject of the shrinking of the doors, and the wear of the locks had been previously under the consideration of the Visitors. The inquiry resulted in a bead being fitted to the door of the room in question, and to some of the other doors,—so that the space between the door and its jamb is covered, and its lock bolt protected.

The accidents in the year have been more remarkable for the ages of the Patients who were the subjects of them,

than for the ill consequences following. They consisted of the following. A Female Patient, aged 72, fell over a basket at which she was shelling peas. She had broken her thigh bone. It united favorably, and she has now for some months walked without a stick. A Male Patient, 80 years of age, failing in health, and tottering with debility, fell against a bed in the Infirmary. Three ribs were fractured. Notwithstanding his failing health, the union of bone was effected without the Patient appearing to suffer from injury.

The occupation of the Patients able to work, has been little otherwise than what has been reported of in former years. Two thirds of the whole number resident in the Asylum have been employed according to their ability. The Women in House, Needle, and Laundry work; the Men in the Grounds of the Asylum to the extent of one-third; a few in Shoe-mending, and in the Workshops; and a remainder suffi-

cient to make up the two-thirds in the Wards.

Importance has recently been given to the much canvassed question of the use of *Sewage* as a Manure in the ground adjoining to an Asylum. The Superintendent of the Asylum for the County of CUMBERLAND has published and circulated, (under the Title of "Sewage exhalations the cause of Dysentery") an account of severe and fatal illness engendered at that Asylum by the exhalations of Sewage which was allowed to run over Grass Land at a distance of 150 yards or more from the Asylum Building. It is sufficient here, as regards that Asylum, that the clearness and satisfactoriness of Dr. Clonston's report are recognised and acknowledged. It is however, a challenge to those Asylums

which continue the use of Sewage, as Manure, to give an authoritative account of the practice of those Asylums, and to shew a justification for it.

The Cumberland Asylum has been open about five years. Referring to the first five years after the opening of the Littlemore Asylum, I may say that it narrowly escaped a similar visitation. The getting rid of the waste of the Asylum was a difficulty which was treated "on the most approved principles." I shall be glad if an exposition of the system pursued here, (which is progressive and followed with the faith of success), may help to clear the difficulty elsewhere. The LITTLEMORE Asylum is on the slope of a Hill of Sand; and is 50 feet above the Watercourse which drains its base. Objection is made to that Watercourse being converted into the Asylum Sewer. It flows close by the Turnpike House; and has, after that, been offensively discolored when checked in its

course before it joins the main River,—the Isis. I have been anxious that the whole of the Sewage should be used on the Asylum Garden. It has however, not hitherto been so used throughout a whole year. But, at the same time, the quantity which has been allowed to run into the Brook, has recently diminished every year.—And the Sewage has, year by year, been more valued for utilisation in the Garden.

The Gardener encourages me to expect that the whole quantity of Sewage from the Asylum will be applied, in this year (1866) on the 16 acres of Garden over which it can flow. The probable amount, (54 Inches in depth), exclusively of 9000 Gallons daily during the dry heat of Summer, equals two average Rainfalls, which are estimated at 27 Inches annually.

The quantity of Water which percolates those acres of sandy soil annually, is equal to a column of seven feet.

There are 20 acres cultivated; and 16 watered; the higher and therefore the drier parts, being more scantily supplied than those at the lower levels.

The supply of Water to the Asylum is from the Brook,—but at a point above that at which it could be contaminated by our Sewage. The Water is raised by Steam Pumps, to Cisterns in the Turrets of the Asylum. And, after being used in the various parts of the House, it converges, in glazed Pipes laid at a fall of one inch in ten feet, to the highest and nearest point of the Garden at which it can be discharged. The quantity of Water, and constancy of flow, are depended on to secure a clear passage: (there not being any cess Tank). The Sewage Water is then discharged on to the surface of the Land which is levelled to a fall of three inches in ten feet,—or it is carried on to a further point of the Garden, by Pipe; according to the position at which it may be wanted. Its speedy use, at an

earlier period of time than will allow of much decomposition, and its diluted state are its securities against the exhalations which have been so prejudicial at the Cumberland Asylum. The Gardener would often desire that the amount of Water was less. The Garden is at present prolific. He calculates on getting his four crops in three years; and occasionally two crops in one year. He needs no fallow. His most difficult season is when severe Frost hardens the Soil so much that he cannot use his Spade. The Sewer Water, ordinarily, penetrates the recently turned soil during a frost; and prepares the Land for an early thaw. The influence of a Manure so minutely divided, and laid on by Water, is enlivened by the earliest Spring, and supported by the latest Sun. The ground is so far prepared for seed; and the young Plants will thrive in a dry Season. The drought of Summer may be paralysed by its action. The rapidity of the succession of Crops depends very much on the rapidity and quantity of

the Manure. It however, needs other than Patients' labor and judgment to sustain such a system of Gardening. There is also a practice of preparing the Ashes for use as Manure. The draining of the Sewage Water, through Ashes, Weeds, and other waste, delays the Water in its course but little, and does not diminish its quantity. The coarser Ashes, Clinkers, and broken Ware, have been used very much in effecting the Land Drainage; which was much needed at the base of the Garden slope. It may be thought that Sewage so much diluted must be inefficiently weak; it may be well therefore to state, that if a stoppage occurs in a drainpipe, and a day or two allowed to pass, so that a state of decomposition is effected (which is certain in about three days); and if the accumulated Sewage is then allowed to flow on to a row of young Cabbage Plants, the Plants flooded will be killed by the strength of the then very offensive Manure. If Cess Tanks were employed to cherish the increased strength,

the increase of Water supplied must be in proportion; and the extent of Tank itself would become an additional difficulty. Although there is no doubt of the benefit of such Manure to Grass Land, if applied, it is considered that it could not be continuously and satisfactorily applied, as the growing Grass would prevent its diffusion. It will run down the drills of growing Plants if the fall of the ground will admit of it; it will spread, or be led over uncultivated Land; but it will not find its own way far against such obstruction as Grass.

The practice of this system has been under the cognisance of the Visitors for about fifteen years. The work of appropriately levelling the ground was commenced at an earlier period. It was long before the continued barrowing of Sand, by Patients,—to improve the level of the Land,—could shew a satisfactory purpose. The prospect of a prolific Soil would probably not have supported

the continuously monotonous and apparently useless labour. It was not the prospect of pecuniary value that ever animated the work. It was that it was absolutely necessary that some wholesome expedient should be created for the management of the increasing wastes of a rapidly increasing Asylum population; for the purification of the Atmosphere which was tainted with the overflow of Cess Tanks; and to secure the health of the Establishment.

It is not necessary for me to raise the question of other courses that might have attained more perfect success, or greater advantages. I confine myself to reporting how the difficulty of earlier years was met at this Asylum; and somewhat of the success which has attended the experiment. It will be for the Visitors to judge of its sufficiency, and to favour its development. The suppression of the knowledge of facts published at another Asylum would not be the course to maintain the confidence of the Visitors of this Asylum, to give due publicity

to what is assumed to be the mastering of a difficulty; or to take the credit which is due to a successful expedient.

The Tables; and the Accounts of the Clerk of the Asylum, are appended to this REPORT.

I have the honor to be

Gentlemen,

Your most obedient Servant

WILLIAM LEY.

*Littlemore Asylum,
30th January 1866.*

Summary of Patients chargeable to the Counties of Oxford and Berks, and to the City and Boroughs of Oxford, Abingdon, and, Reading in the year 1865.

	Male.	Female.	Total.
Remained in the Asylum at Littlemore December 31, 1864	324	255	479
Ditto ditto at Stone	10	10	20
Ditto ditto at Powick	6	30	36
Ditto ditto at Bethnal Green	6	23	29
Received in the year 1865	69	62	131
Total	309	370	679
Discharged on Recovery	24	31	55
Ditto to the care of their Friends	2	2	4
Removed to Asylums to which chargeable	3	1	4
Dead in the Asylum at Littlemore	18	24	42
Ditto Bethnal Green	3	3	6
Total decrease	47	62	109
Remains, December 31, 1865	262	308	570
Are in the Asylum at Littlemore	220	253	473
" Stone	7	7	14
" Powick	30	30	60
" Charnminster	35	25	60
Total as above	262	308	570
Re-admissions:			
Within 12 months of discharge	3	6	9
After longer periods	6	5	11
Admissions by removal from other Asylums	1	6	7
" after discharge from other Asylums	7	5	12
" by order of the Secretary of State	3	3	6
Increase in the number of Patients under charge in 1865	22	22	44
The lowest number of Male Patients at Littlemore on any day in 1865	204	240	444
Ditto Female Patients	236	255	491
Total number of Male and Female Patients	236	255	491
The highest number of Male Patients	236	255	491
Total number of Male and Female Patients	236	255	491
Average number resident during 1865	219	247	466

Ages and other Statistics of 679 Patients in 1865: being the whole number chargeable to the Littlemore Asylum.

Patients.	In the 1st year of Insanity.		Lengthened Insanity.		Total.		Discharged.		Died.		Epileptic.		Epileptic and Manic.		Idiot.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Under 10 years of age																
From 10 to 15	1	5	1	5	1	5	1	5	1	5	1	5	1	5	1	5
15 to 20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20 to 25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25 to 30	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30 to 35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35 to 40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40 to 45	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45 to 50	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
50 to 55	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
55 to 60	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
60 to 65	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
65 to 70	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
70 to 75	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
75 to 80	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
80 to 85	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
85 and upwards	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total.....	55	61	54	59	109	120	55	58	27	25	65	64	11	43	11	43
Discharged.....	17	12	13	12	30	25	64									
Died.....	10	8	8	5	18	13	31									
Total deceased.....	10	8	8	5	18	13	31									
Remains.....	47	61	46	57	103	107										

Summary of the Admissions, Discharges, Deaths, and Terms of Residence of Patients from the opening of the Asylum in July 1845 to December 31, 1865.

Of the Year.	Previously to January 1st 1845.				To December 31, 1865.				Deaths.			
	Admissions.	Recovered or Relieved.	Not Relieved.	Died.	Admissions.	Recovered or Relieved.	Not Relieved.	Died.	Admissions.	Recovered or Relieved.	Not Relieved.	Died.
1846	122	9	1	1	122	9	1	1	122	9	1	1
1847	170	27	1	1	170	27	1	1	170	27	1	1
1848	170	27	1	1	170	27	1	1	170	27	1	1
1849	149	54	1	1	149	54	1	1	149	54	1	1
1850	180	60	1	1	180	60	1	1	180	60	1	1
1851	174	55	1	1	174	55	1	1	174	55	1	1
1852	174	55	1	1	174	55	1	1	174	55	1	1
1853	107	43	9	9	107	43	9	9	107	43	9	9
1854	125	50	1	1	125	50	1	1	125	50	1	1
1855	108	26	1	1	108	26	1	1	108	26	1	1
1856	108	26	1	1	108	26	1	1	108	26	1	1
1857	153	83	1	1	153	83	1	1	153	83	1	1
1858	118	57	1	1	118	57	1	1	118	57	1	1
1859	144	64	1	1	144	64	1	1	144	64	1	1
1860	128	59	1	1	128	59	1	1	128	59	1	1
1861	150	61	1	1	150	61	1	1	150	61	1	1
1862	150	61	1	1	150	61	1	1	150	61	1	1
1863	151	40	1	1	151	40	1	1	151	40	1	1
1864	151	40	1	1	151	40	1	1	151	40	1	1
1865	151	40	1	1	151	40	1	1	151	40	1	1
Total.....	1037	57	866	87	1037	57	866	87	1037	57	866	87

Obituary of Males, 1865.

Name.	Age.	Duration of Insanity.		Cause of Death.
		Prior to Admission.	Subsequent to Admission.	
W. W.	51	1 year.	4 years.	Brain firm. Ventricles dilated with fluid. Hypertrophy of the Heart.
J. G.	55	3 months.	4 months.	Paralysis with Epilepsy. Brain soft.
G. L.	57	3 months.	3 months.	Paralysis. Cerebral membrane opaque. Brain firm.
W. D.	45	many years.	2 months.	Paralysis. Cerebral membrane opaque. Brain firm.
W. M.	76	2 weeks.	2 years.	General Paralysis. Brain very tough. Emphysema of the Lungs.
J. H.	41	unknown.	9 months.	General Paralysis. Contraction of the Brain. Hypertrophy of the Heart.
J. D.	56	1 month.	24 years.	Epilepsy of the Leg. Paralysis with Epilepsy.
J. C.	60	6 weeks.	6 weeks.	General Paralysis. Brain very tough. Emphysema of the Lungs.
G. G.	40	6 months.	64 months.	General Paralysis. Brain very tough. Emphysema of the Lungs.
J. B.	58	3 months.	1 month.	General Paralysis. Brain very tough. Emphysema of the Lungs.
W. F.	78	1 month.	4 months.	General Paralysis. Brain very tough. Emphysema of the Lungs.
T. H.	47	1 month.	4 months.	General Paralysis. Brain very tough. Emphysema of the Lungs.
T. B.	76	6 years.	33 months.	General Paralysis. Brain very tough. Emphysema of the Lungs.
W. B.	48	unknown.	14 months.	General Paralysis. Brain very tough. Emphysema of the Lungs.
R. C.	85	many years.	33 years.	General Paralysis. Brain very tough. Emphysema of the Lungs.

Obituary of Females, 1865.

Name.	Age.	Duration of Insanity.		Cause of Death.
		Prior to Admission.	Subsequent to Admission.	
M. W.	80	4 weeks.	74 years.	Paralysis. Cerebral membranes thickened. Hypertrophy of the Heart.
S. C.	27	unknown.	9 months.	General Paralysis. Old cerebral disease.
H. E.	4	many years.	84 years.	Epilepsy. Cerebral membranes opaque. Brain very tough.
M. A. G.	79	4 years.	34 years.	General Paralysis. Brain very tough. Old cerebral disease.
M. A. N.	35	unknown.	2 years.	Paralysis. Brain very tough. Old cerebral disease.
M. C.	64	1 month.	7 months.	Paralysis. Brain very tough. Old cerebral disease.
L. M.	16	3 years.	14 years.	General Paralysis. Brain very tough. Old cerebral disease.
B. W.	68	1 month.	64 months.	General Paralysis. Brain very tough. Old cerebral disease.
M. B.	77	6 years.	34 years.	General Paralysis. Brain very tough. Old cerebral disease.
E. C.	34	17 years.	2 years.	General Paralysis. Brain very tough. Old cerebral disease.
E. A.	39	34 years.	24 years.	General Paralysis. Brain very tough. Old cerebral disease.
E. P.	53	unknown.	54 years.	General Paralysis. Brain very tough. Old cerebral disease.
S. J.	45	many years.	14 months.	General Paralysis. Brain very tough. Old cerebral disease.
J. C.	24	4 years.	3 months.	General Paralysis. Brain very tough. Old cerebral disease.
M. A. G.	67	20 years.	74 years.	General Paralysis. Brain very tough. Old cerebral disease.
L. C.	23	from birth.	8 months.	General Paralysis. Brain very tough. Old cerebral disease.
C. G.	14	1 year.	13 years.	General Paralysis. Brain very tough. Old cerebral disease.
E. G.	55	1 year.	13 years.	General Paralysis. Brain very tough. Old cerebral disease.

Members received from each Body of the Asylum Union.

gdon.	Reading.					Total.		December 31.
	Discharged.	Died.	January 1st.	Admitted.	Discharged.	Discharged.	Died.	
1						11	1	110
1	1					31	16	134
2	1	3	4		1	30	30	231
2	1	18	6		2	57	39	286
3	1	19	6	1	2	60	20	316
3		22	4		1	60	33	347
1	1	23	1			46	44	366
1	1	22	5			44	34	394
1		25	9		3	60	50	409
2	1	29	9			53	45	475
		36	13		4	51	40	441
6	2	40	6		5	56	46	464
2	2	39	5		3	70	38	473
3	1	39	13		6	66	46	504
1	1	41	11		6	74	68	507
3	1	41	15		3	60	70	525
1	3	48	7		4	66	65	544
2	5	50	10		5	10	84	57
2	5	45	15		12	7	76	548
2	3	41	10		7	2	64	45

the Transfers of chargeability ; consequently it does not. Any statement made at the Asylum is liable to be as any part of its business. Precise accuracy on

Table of the Number of Patients in the Asylum in each Year, showing the Numbers received from each Body of the Asylum Union.

	Patients.			Oxfordshire.			Berkshire.			Oxford.			Abingdon.			Reading.			Total.		
	January int.	Admitted.	Total.	January int.	Admitted.	Discharged.	January int.	Admitted.	Discharged.	January int.	Admitted.	Discharged.	January int.	Admitted.	Discharged.	January int.	Admitted.	Discharged.	Discharged.	December 31.	
1846		122	122		103	11				19									11	110	
1847	110	71	181	91	43	18	12	6	86	6	9	23	9	5	1	5	1	1	31	16	
1848	134	159	293	104	55	20	14	6	70	19	15	24	14	80	15	4	2	3	30	23	
1849	233	149	382	125	45	26	22	77	70	19	15	24	14	80	15	4	2	3	30	23	
1850	286	120	406	122	50	27	9	113	50	24	5	29	11	8	3	3	3	1	37	29	
1851	316	114	440	136	62	24	20	134	34	23	9	29	12	9	3	5	2	2	60	20	
1852	347	109	456	144	44	23	21	136	46	15	17	29	13	8	5	5	1	1	46	33	
1853	386	107	493	154	43	19	19	150	45	14	11	32	9	5	3	5	1	1	46	33	
1854	394	125	519	164	58	29	22	169	43	22	20	30	14	6	6	1	1	25	44	39	
1855	409	102	511	171	41	29	20	170	43	16	16	33	7	4	8	3	2	1	53	45	
1856	413	119	532	163	46	18	16	180	43	20	19	28	16	8	1	6	1	1	53	45	
1857	441	153	595	175	62	32	27	184	62	23	18	35	16	12	4	2	7	6	51	40	
1858	464	118	582	178	44	27	16	205	51	31	17	26	15	10	6	2	7	2	51	40	
1859	474	143	616	179	44	22	16	208	60	26	21	41	17	9	3	2	8	3	51	40	
1860	504	145	649	185	65	37	24	221	54	24	29	46	9	7	8	11	6	1	51	40	
1861	507	148	655	189	59	17	26	222	57	32	35	40	12	3	5	5	3	1	51	40	
1862	525	150	675	205	70	31	19	212	52	29	11	44	19	4	8	16	2	1	51	40	
1863	544	144	688	225	51	32	18	204	60	31	20	51	17	13	4	14	6	2	51	40	
1864	547	151	698	225	55	32	37	213	61	26	21	51	13	4	13	6	3	3	51	40	
1865	548	131	679	211	43	17	12	229	65	29	23	53	10	9	5	14	4	2	51	40	

This Table which gives the number of Admissions in each year, does not give the Transfers of chargeability; consequently it does not give with accuracy the number of Patients chargeable to each body in the Union. Any statement made at the Asylum is liable to inaccuracy. The chargeability of Patients is not fixed at the Asylum, or regarded as any part of its business. Precise accuracy on that point is not necessary to it.

which they are

Remain.			
December 31.			
Total.	Males.	Females.	Total.
12	20	15	35
6	15	23	38
3	8	12	16
3	16	10	26
4	16	10	26
3	6	7	13
1	3	8	11
7	9	10	19
4	11	15	26
3	9	18	27
4	9	15	24
4	10	17	27
13	18	23	41
10	19	17	36
1	5	4	10
3	14	14	28
5	13	14	27
4	17	14	31
4	16	18	34
8	20	14	34
6	10	14	24
1	4	3	7
	2	1	3
	3	1	4
	2	1	3
	1		1
4			

LITTLEMORE ASYLUM. ACCOUNT

OF THE
RECEIPTS AND PAYMENTS
BY THE TREASURER

For the Year ending 31st December 1865.

RECEIPTS.

	£.	s.	d.	£.	s.	d.
Balance of last year's account in the Treasurer's hands				1308	9	2
Ditto in the House Steward's hands				76	5	1
1. FROM SALE OF						
Produce of Garden, (ex- clusive of the consump- tion in the House)	74	6	7			
Live Stock (ditto)	110	17	8			
Kitchen Stuff	30	9	11			
				215	14	2
2. FOR MAINTENANCE OF PATIENTS from Unions and Parishes in Oxford- shire and Berkshire.						
Abingdon Union	*1008	2	2			
Banbury Union	980	10	0			
Bicester Union	424	19	4			
Brackley Union	59	0	4			
Bradfield Union	595	15	10			
Chipping Norton Union	662	18	6			
Cookham Union	329	7	9			
Easthampstead Union	253	17	10			
Faringdon Union	579	10	1			
Headington Union	648	7	4			
Henley Union	*806	7	4			
Hungerford Union	550	13	1			
Newbury Union	616	4	8			
Oxford Union	999	14	5			
Reading Union	912	19	9			
Thame Union	283	12	3			
Carried forward	9712	0	8	1600	8	5

* The sums thus marked include arrears of 1864.

Table of the number of Patients in the Asylum at Littlemore, and of the Unions to which they are chargeable in the Year 1865.

UNION.	1865.														
	Remaining in Asylum.						Decrease.						Remain.		
	January 1.			Admitted.			Discharged.			Died.			December 31.		
	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.
Abingdon	18	18	36	7	4	25	22	47	3	2	2	5	7	12	35
Banbury	15	26	41	1	2	10	28	44	1	4	1	1	5	6	11
Bicester	5	12	17	2	2	5	14	19	1	1	1	1	2	3	5
Bradfield	6	15	21	3	4	9	19	28	2	1	1	1	3	4	7
Chipping Norton	13	11	24	4	2	17	13	20	1	1	2	1	3	4	7
Cookham	6	9	15	1	1	2	9	16	1	1	2	1	2	3	5
Easthampstead	2	6	8	1	3	3	9	12	1	1	1	1	1	1	2
Farington	9	8	17	3	6	12	14	26	3	3	1	3	4	7	10
Headington	11	15	26	1	3	12	18	30	1	1	2	1	3	4	7
Henley-on-Thames	7	16	23	3	4	10	20	30	1	1	1	1	2	3	5
Hungerford	9	12	21	4	3	13	15	28	2	2	4	4	9	13	22
Newbury	8	18	26	2	1	10	19	29	2	1	1	1	3	4	7
Oxford	17	27	44	5	5	22	32	54	2	6	2	3	9	11	20
Reading	20	15	35	4	7	24	22	46	4	4	1	1	5	10	15
Thame	7	4	11	2	1	9	4	13	1	1	1	1	1	1	2
Wallingford	13	16	29	1	1	14	16	30	2	1	1	1	2	3	5
Wantage	11	12	23	5	4	16	16	32	1	3	1	3	2	5	7
Windsor	12	15	27	6	2	18	17	35	1	1	1	1	1	2	3
Winney	16	16	32	1	3	17	19	36	1	1	1	1	1	2	3
Wokingham	16	16	32	7	3	21	19	42	2	1	4	3	5	8	13
Woodstock	9	11	20	5	5	14	16	30	3	1	1	1	4	6	10
Wycombe	4	3	7	1	1	5	3	8	1	1	1	1	1	1	2
Brackley	1	1	2	1	2	1	1	3	1	1	1	1	1	1	2
Oxfordshire	2	1	3	1	1	3	1	4					3	1	4
Berkshire	5	1	6						3				2	1	3
Oxford City															
Abingdon															
Reading	1	1	2										1		1
Windsor	2	2	4	1	1	3	1	4	3	1					
Out County Unions															

LITTLEMORE

RECEIPTS BY THE For the Year of

Balance of last year's account in the Treasurer's hands
Ditto in the House Steward's hands

1. FROM SALE OF
Produce of Garden, (exclusive of the consumption in the House)
Live Stock (ditto)
Kitchen Stuff

2. FOR MAINTENANCE OF
PATIENTS from Unions and Parishes in Oxfordshire and Berkshire.

Abingdon Union
Banbury Union
Bicester Union
Brackley Union
Bradfield Union
Chipping Norton Union
Cookham Union
Easthampstead Union
Farington Union
Headington Union
Henley Union
Hungerford Union
Newbury Union
Oxford Union
Reading Union
Thame Union

Carried forward

* The sums shown

RECEIPTS.

	£	s.	d.	£	s.	d.
Brought forward	9712	0	8	1600	8	5
Wallingford Union	693	5	7			
Wantage Union	600	10	8			
Windsor Union	733	19	3			
Witney Union	817	3	4			
Wokingham Union	791	0	6			
Woodstock Union	503	3	8			
Wycombe Union	170	5	2			
County of Oxford	82	17	6			
County of Berks	130	5	0			
City of Oxford	7	1	6			
Borough of Windsor	25	2	4			
				14266	15	2
(2.) From other Unions.						
Chichester Union	8	16	0			
Medway Union	26	4	2			
Swindon Union	8	16	2			
				43	16	4
N.B. The Weekly charge for Maintenance was during the first two quarters of the year, nine shillings and six-pence, and for the last two quarters, nine shillings and nine-pence.						
3. EXTRA CHARGES.						
Admissions, Removals, &c.						
Abingdon Union	6	6	1			
Banbury Union	19	6				
Bicester Union	19	6				
Bradfield Union	19	6				
Chipping Norton Union	1	19	0			
Cookham Union	2	14	0			
Faringdon Union	2	6	11			
Headingdon Union	19	6				
Henley Union	1	19	0			
Hungerford Union	6	10	7			
Newbury Union	3	2	6			
Oxford Union	3	13	6			
Reading Union	3	8	0			
Thame Union	19	6				
Wantage Union	3	13	6			
Windsor Union	3	7	0			
Wokingham Union	7	9	0			
Woodstock Union	1	19	0			
City of Oxford	5	5	0			
County of Berks	1	12	0	55	2	7
				15966	2	6

1. SALARIES AND WAGES.

(1.) Establishment.

	£	s.	d.
Officers—			
Superintendent	112	10	0
Medical Assistant	30	0	0
Chaplain	45	0	0
Clerk of the Visitors	11	10	0
Treasurer	..	..	..
Auditor	12	10	0
Clerk of the Asylum	30	0	0
Housekeeper	10	0	0
Attendants—			
Head Male Attendant	9	4	8
Ditto Female ditto	6	5	0
Ditto ditto Laundry ditto	6	5	0
Eleven Male Sub-Attendants for part of the year [5 at £35, 1 at £21, and 5 at £20]	57	17	6
Three Female Sub-Attendants as Nurses to the Male Infirmary for part of the year, at 8/9 per week each	15	15	0
Fifteen Female Sub-Attendants for part of the year, [3 at £18, 4 at £16 and 8 at £14]	58	19	6
Two Male Night Attendants at 14/- per week each	16	16	0
Two Female Night Attendants [1 at £18 and 1 at £16]	8	10	0
Servants—			
In-door—			
Porter	6	5	0
Cook	4	10	0
Kitchen Maid	3	10	0
Two House Maids [1 at £14 and 1 at £10]	6	0	0
Four Laundry Maids for part of the year, [2 at £16, 1 at £12 and 1 at £10]	13	0	0
Out-door—			
Fireman at 16/- per week and extra time	9	16	3
Two Stokers [1 at 15/- and 1 at 13/6 per week and extra time]	19	0	10
	513	4	9
At a cost per head per week of	0	1	8
The cost for the whole year is	0	1	8

PAYMENTS.

35

I. SALARIES AND WAGES. (1.) Establishment.

	1st Quarter 31st March.	2nd Quarter 30th June.	3rd Quarter 30th Sept.	4th Quarter 31st Dec.	For the Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Officers:—					
Superintendent	112 10 0	112 10 0	112 10 0	112 10 0	450 0 0
Medical Assistant	30 0 0	30 0 0	30 0 0	30 0 0	120 0 0
Chaplain	45 0 0	45 0 0	45 0 0	45 0 0	180 0 0
Clerk of the Visitors	31 10 0	31 10 0	31 10 0	31 10 0	126 0 0
Treasurer .....	.. ..	.. ..	.. ..	30 0 0	30 0 0
Auditor	12 10 0	12 10 0	12 10 0	.. ..	37 10 0
Clerk of the Asylum	30 0 0	30 0 0	30 0 0	30 0 0	120 0 0
Housekeeper	10 0 0	10 0 0	10 0 0	10 0 0	40 0 0
Attendants:—					
Head Male Attendant	9 4 8	10 0 0	10 15 4	10 0 0	40 0 0
Ditto Female ditto	6 5 0	6 5 0	6 5 0	6 5 0	25 0 0
Ditto ditto Laundry ditto	6 5 0	6 5 0	6 5 0	6 5 0	25 0 0
Eleven Male Sub-Attendants for part of the year [5 at £25, 1 at £21, and 5 at £20]	57 17 6	60 8 7	63 4 1	64 6 6	245 16 8
Three Female Sub-Attendants as Nurses to the Male Infirmary for part of the year, at 8/9 per week each	15 15 0	16 11 3	13 7 6	11 7 6	57 1 3
Fifteen Female Sub-Attendants for part of the year, [3 at £18, 4 at £16 and 8 at £14]	58 19 6	57 10 0	53 5 5	52 8 10	222 3 9
Two Male Night Attendants at 14/- per week each	16 16 0	18 4 0	19 12 0	18 4 0	72 16 0
Two Female Night Attendants [1 at £18 and 1 at £16]	8 10 0	8 10 0	8 10 0	8 10 0	34 0 0
Servants:—					
In-door:—					
Porter	6 5 0	6 5 0	6 5 0	6 5 0	25 0 0
Cook	4 10 0	4 10 0	4 10 0	4 10 0	18 0 0
Kitchen Maid	3 10 0	3 10 0	3 10 0	3 15 1	14 5 1
Two House Maids [1 at £14 and 1 at £10]	6 0 0	6 0 0	6 0 0	6 0 0	24 0 0
Four Laundry Maids for part of the year, [2 at £16, 1 at £12 and 1 at £10]	13 0 0	13 10 0	13 1 0	13 10 0	53 1 0
Out-door:—					
Fireman at 16/- per week and extra time	9 16 3	10 17 10	11 14 7	11 3 9	43 12 5
Two Stokers [1 at 15/- and 1 at 13/6 per week and extra time]	19 0 10	20 16 11	22 4 0	20 9 4	82 11 1
	513 4 9	520 13 7	519 18 11	532 0 0	
At a cost per head per week of	0 1 8 79	0 1 8 03	0 1 8 90	0 1 8 31	
The cost for the whole year is	0 1 8 25	per head per week			

Carried forward £2085 17 3

PAYMENTS.

	First Quarter 31st March.	£	s.	d.	
Brought forward					
(a.) PROVISIONS (see table of comparative prices post.)					
Bacon	245 lbs 6/-	6	13	6	292 1/2 lb
Beer	6 barrels 12/-	9	12	0	7 barre
Ditto	156 ditto 12/-	17	12	0	154 dit
Bread in 4lb loaves	10830 loaves 4d.	180	10	0	10,770 l
Butter (salt)	443 lbs 12 1/2/-	25	0	8	937 lbs
Ditto (fresh)	338 lbs.	15	17	10	338
Cheese	469 1/2 lbs. 80/-	16	15	1	388 lb
Ditto	2314 1/2 lbs. 63/-	65	1	9	2,601 l
Currants	..	..	..	..	..
Eggs	1,620	6	6	0	1,620
Flour	36 sacks 28/6	51	6	0	35 sack
Meat.	15847 lbs. 6 1/2 d.	429	3	9	18,285
Prime Joints	691 lbs. 6 1/2 d.	18	14	3 1/2	2,238 1/2
Lamb	..	..	..	..	..
Sides of Beef	4890 lbs. 6 1/2 d.	132	8	9	1,660 l
Boned Beef	477 lbs. 6 1/2 d.	12	18	4 1/2	550 lb
Beef Suet	350 lbs. 6 1/2 d.	9	15	0	485 lb
Mutton Suet	360 lbs. 6 1/2 d.	9	15	0	495 lb
Shins of Beef	8 1/6	0	12	0	..
Milk	1620 gallons 7 1/2 d.	50	12	6	1,638 gal
Raisins	..	..	..	..	..
Rice	980 lbs. 16/-	7	0	0	672 lb
Sugar (loaf)	84 lbs. 47/-	1	15	3	84 lbs
Ditto (molit)	448 lbs. 36/-	7	4	0	336 lb
Ditto (ditto)	2464 lbs. 34/-	37	8	0	2,464 l
Tea	150 lbs. 3/3	24	7	6	150 lb
Ditto	290 lbs. 2/8	38	13	4	290 lb
Tobacco and Snuff	..	17	18	11	..
Treacle	..	3	11	10	..
Vinegar, Salt, Mustard, and Pepper	..	4	6	4	..
Miscellaneous (Arrowroot)	..	10	3	8	..
		1,375	3	4	
At a cost per head per week of	..	0	4	6 55	
The cost for the whole year is	..	0	4	10 1/2 1/2	per head p
(3.) WINE, SPIRITS, AND PORTER					
Wine and Spirits	..	12	12	0	..
Porter	..	5	6	0	..
		17	18	0	
At a cost per head per week of	..	0	0	3 1/2	
The cost for the whole year is	..	0	0	2 1/2 1/2	per head p

	First 31st	For the Year.
Brought forward		8,103 5 1 1/2
(4.) MISCELLANEOUS. Fuel, Lighting and Washing		
Candles (composition)	..	0
Ditto (dips)	312 lbs. 5/-	3
Carriage of Coal and Coke	..	0
Chimney Sweep	..	0
Coal (Best Pinxton hard)	100 tons 2/-	0
Ditto (Deep Cannon Chase)	8 9-10 ditto	0
Coke	28 5-10 ditto	0
Hearth Stones	..	0
Holly	..	0
House Cloths	..	1
Lamp Cottons	..	4
Lamp Glasses	..	0
Musicians	..	0
Oil (Southern)	315 1/2 gallons	1
Ditto (Sperm)	24 ditto	6
Ditto (Colza)	51 5-8 ditto	0
Soap (yellow)	3650 lbs.	0
Ditto (ditto)	360 lbs.	0
Ditto (soft)	384 lbs. 1/-	0
Soda	2,147 lbs. 5/-	9
Starch and Blue	..	0
Charwoman and Knife Cleaner	..	4
Horse Hire to Pump Water	..	0
Wood	..	4
Miscellaneous (Blacking &c.)	..	0
	7	1,545 0 10 1/2
At a cost per head per week of	..	10
The cost for the whole year is	..	..
(5.) SURGERY AND DISPENSARY.		
Drugs	..	8
Occasional Medical Assistance	..	0
Sundries	..	0
	8	51 18 6
At a cost per head per week of	..	39
The cost of the whole year is	..	2,969 18 6

PAYMENTS.

36

	First Quarter 31st March.	Second Quarter 30th June.	Third Quarter 30th Sept.	Fourth Quarter 31st Dec.	For the Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Brought forward					2,085 17 3
(2.) PROVISIONS (see table of comparative prices post.)					
Bacon	245 lbs 61/-	292½ lbs. 65/-	277½ lbs. 74/-	294½ lbs. 74/-	9 14 7
Beer	6 barrels 32/-	7 barrels 32/-	7½ barrels 32/-	9½ barrels 32/-	15 4 0
Ditto	156 ditto 22/-	154 ditto 22/-	158 ditto 22/-	158 ditto 22/-	173 16 0
Bread in 4lb loaves	10830 loaves 4d.	10,770 loaves 4d.	10,685 loaves 4d.	10,890 loaves 4d.	198 10 3
Butter (salt)	445½ lbs 126/-	937 lbs. 118/-	815½ lbs. 114/-	1,064 lbs. 125/-	59 7 4
Ditto (fresh)	338 lbs.	338 lbs.	338 lbs.	338 lbs.	26 10 10
Cheese	460½ lbs. 80/-	388 lbs. 82/-	434 lbs. 78/-	472 lbs. 82/-	17 5 7
Ditto	2314½ lbs. 63/-	2,601 lbs. 64/-	2883 lbs. 68/-	2,897 lbs. 66/-	85 7 2
Currants	1,620	1,800	2,040	2,220	2 16 0
Eggs	36 sacks 28/6	35 sacks 28/6	32 sacks 29/-	33 sacks 32/-	11 2 0
Flour	15847 lbs. 6½d.	18,283 lbs. 7d.	19,367 lbs. 7d.	16,749 lbs. 7½d.	523 8 1
Meat.	691 lbs. 6½d.	2,238 lbs. 8d.	2,875½ lbs. 8d.	2,463 lbs. 9d.	92 7 3
Lamb	4890 lbs. 6½d.	1,660 lbs. 6½d.	2,296 lbs. 7d.	2,296 lbs. 7d.	66 19 4
Sides of Beef	477 lbs. 6½d.	550 lbs. 5d.	376 lbs. 6d.	531 lbs. 6d.	13 5 6
Boned Beef	360 lbs. 6½d.	425 lbs. 6d.	60 lbs. 6d.	112 lbs. 7½d.	3 10 0
Beef Suet	360 lbs. 6½d.	495 lbs. 5d.	900 lbs. 6d.	790 lbs. 5½d.	18 2 1
Mutton Suet	8 1/6	...	...	six 2/-	0 12 0
Shins of Beef	1620 gallons 7½d.	1,638 gallons 7½d.	1,638 gallons 7½d.	1,674 gallons 7½d.	52 6 3
Milk	980 lbs. 16/-	672 lbs. 15/6	588 lbs. 15/6	672 lbs. 15/6	3 5 4
Raisins	84 lbs. 47/-	84 lbs. 47/-	84 lbs. 45/6	84 lbs. 47/6	4 13 0
Rice	448 lbs. 36/-	336 lbs. 35/6	448 lbs. 37/-	336 lbs. 38/6	1 15 7
Sugar (loaf)	2464 lbs. 34/-	2,464 lbs. 33/-	2,464 lbs. 34/6	2,464 lbs. 36/6	5 15 6
Ditto (moist)	150 lbs. 3/3	150 lbs. 3/3	150 lbs. 2/9	150 lbs. 2/9	40 3 0
Ditto (ditto)	290 lbs. 2/8	290 lbs. 2/8	290 lbs. 2/3	290 lbs. 2/3	20 12 6
Tea	...	...	...	...	32 12 6
Tobacco and Snuff	...	...	...	...	19 0 5
Treacle	...	...	...	...	3 11 11
Vinegar, Salt, Mustard, and	...	...	...	...	...
Pepper	...	...	...	...	...
Miscellaneous (Arrowroot)	...	...	...	...	...
At a cost per head per week of	1,375 3 4	1,482 19 1½	1,490 14 6	1,577 1 11	5,925 18 10½
The cost for the whole year is	0 4 6 55	0 4 10½ 65	0 4 11½ 70	0 5 14 97	...
(3.) WINE, SPIRITS, AND PORTER					
Wine and Spirits	12 12 0	21 16 0	13 6 0	...	19 18 0
Porter	5 6 0	5 19 3	6 12 6	...	5 19 3
At a cost per head per week of	17 18 0	27 15 3	19 18 6	25 17 3	91 9 0
The cost for the whole year is	0 0 0 81	0 0 1 37	0 0 0 17	0 0 1 05	...
Carried forward					8,103 5 1½

PAYMENTS.

37

	First Quarter 31st March.	Second Quarter 30th June.	Third Quarter 30th Sep.	Fourth Quarter 31st Dec.	For the Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Brought forward					8,103 5 1½
(4) NECESSARIES. Fuel, Lighting and Washing:—					
Candles (composition)			1 3 0	48 lbs. 11/6	2 6 0
Ditto (dips)	312 lbs. 5/-	144 lbs. 4/11½	24 lbs. 11/6	465 lbs. 5/6	10 12 2
Cartage of Coal and Coke	2 16 6	4 9 9	144 lbs. 4/11½	7 1 0	6 7 0
Chimney Sweep	1 10 0	0 18 0	2 1 0	2 1 0	1 17 0
Coal (Best Pinxton hard)	100 tons 21/-	150 tons 20/-	518 0 0	0 0 0	0 0 0
Ditto (Deep Cannock Chase)	8 9-20 ditto 17/6	7 7 11	560 tons 18/6	0 0 0	0 0 0
Coke	28 5-20 ditto 10/-	41½ tons 10/-	35 5 0	63½ tons 10/-	31 15 0
Hearth Stones	2 8 0	1 4 0	70½ tons 10/-	0 0 0	2 8 0
Holly	0 0 0	1 4 0	0 0 0	0 0 0	1 0 0
House Cloths	7 6 10½	9 1 1½	7 15 3	7 15 3	7 15 3
Lamp Cottons	4 10 0	3 0 0	4 8 0	4 8 0	6 2 4
Lamp Glasses	4 1 0	2 14 0	2 14 0	2 14 0	4 12 0
Musicians	3 3 0	0 0 0	0 0 0	0 0 0	2 10 0
Oil (Southern)	315½ gallons 4/-	55 gallons 3/11	52 gallons 3/10½	10 1 6	482 gallons and a fraction at 3/11½
Ditto (Sperm)	24 ditto 6/4	7 12 0	0 0 0	0 0 0	21 gallons and a fraction at 4/4
Ditto (Colza)	21 5-8 ditto 4/1	21½ gallons 4/-	21½ gallons 3/10	4 6 3	4 13 6
Sap (yellow)	3,360 lbs. 31/-	3,808 lbs. 31½/-	3,696 lbs. 30/9	50 14 9	54 9 0
Ditto (ditto)	360 lbs. 27/-	2 14 7	0 0 0	0 0 0	0 0 0
Ditto (soft)	384 lbs. 15/3	320 lbs. 14/9	4 8 6	384 lbs. 15/6	4 13 0
Soda	2,147 lbs. 5/4½	1,694 lbs. 5/4½	384 lbs. 14/9	4 10 6	4 10 9
Starch and Blue	1 0 7½	3 2 9	1,886 lbs. 5/4½	2 19 7	2 19 0
Charwoman and Knife Cleaner	7 6 8	9 3 4	0 0 0	9 0 4	9 11 4
Horse Hire to Pump Water	0 0 0	0 0 0	1 4 0	0 0 0	0 0 0
Wood	0 4 2	25 10 0	0 0 0	0 0 0	1 18 2
Miscellaneous (Blackening &c.)	3 0 0	3 10 2	2 5 2	0 0 0	0 0 0
	344 7 8½	311 19 3	673 5 4	255 8 7	1,545 0 10½
At a cost per head per week of	0 0 11½93	0 1 0½15	0 2 2½35	0 0 10	0 0 10
The cost for the whole year is	0 1 3½10	per head per week.	0 2 2½35	0 0 10	0 0 10
(5) SURGERY AND DISPENSARY.					
Drugs	20 3 8	0 0 0	16 3 8	2 10 8	2 10 8
Occasional Medical Assistance	5 5 0	4 4 0	2 2 0	0 0 0	0 0 0
Sundries	0 0 0	1 3 6	0 0 0	0 0 0	0 0 0
	25 8 8	5 7 6	18 5 8	2 10 8	51 12 6
At a cost per head per week of	0 0 1	0 0 0 84	0 0 0½91	0 0 39	0 0 39
The cost of the whole year is	0 0 0½103	per head per week.	0 0 0½91	0 0 39	0 0 39
Carried forward					£9,699 18 6

PAYMENTS.

	First Quarter 31st March.		
	£	s.	d.
Brought forward			
(6.) CLOTHING.			
Boots and Shoes	..	..	..
Bonnets (straw)	..	..	..
Buttons	..	..	..
Calico (colored)	..	..	..
Ditto (blue)	..	..	..
Ditto (shirting)	..	..	..
Ditto (ditto stout)	..	..	..
Ditto (unbleached)	..	..	..
Ditto (ditto stout)	..	..	..
Caps (women's)	..	..	..
Cloth (men's grey)	630½ yards 6¼	193	1 10
Ditto (men's striped tweed)	..	..	..
Ditto (men's steel ditto)	..	..	..
Ditto for a suit of clothes	..	..	..
Cotton (men's)	..	..	..
Ditto (darning)	..	..	..
Forfar (stout)	..	..	..
Ditto (towel)	..	..	..
Ditto (wrapping)	..	..	..
Flannel (Welsh)	..	..	..
Handkerchiefs (men's)	..	..	..
Ditto (women's)	..	..	..
Hats (felt)	..	..	..
Laces (boot)	..	..	..
Ditto (stay)	..	..	..
Leather & Materials for Shoes	..	..	..
Linen check	..	..	..
Ditto (ticking)	..	..	..
Neckkerchiefs (men's)	..	..	..
Stockings (men's worsted)	..	..	..
Ditto (men's cotton)	..	..	..
Ditto (women's ditto)	..	..	..
Shoemaker	..	..	..
Tailor	..	..	..
Type (brown)	..	..	..
Ditto (white)	..	..	..
Twill	..	..	..
Worsted	..	..	..
Thread, Needles, &c.	..	..	..
	377	19	6½
At a cost per head per week of	..	..	..
The cost for the whole year is	..	..	..

PAYMENTS.

	1st Q	31st
	£	
Brought forward		
7. FURNITURE		
Baskets	4	
Blankets	..	
Chairs (Windsor)	..	
Chamber Ware of Gutta Percha	..	
Clothes Lines	..	
Combs and Brushes	..	
Crockery	..	
Culinary utensils, Brushes, Mops, &c.	..	
Cutlery repairs	..	
Dowels for sheets	..	
Huckaback for Table Cloths	..	
Horse-hair for Mattresses	..	
Lamps and Lanthorns	..	
Mats	..	
Pails	..	
Razors	..	
Razor-strops	..	
Sackings	..	
Shoe-brushes	..	
Spectacles	..	
Sponge	..	
Ticking for Mattresses	..	
Tin baking dishes	..	
Tin cans	..	
Twine	..	
Upholsterer	..	
Ward Whistles and rings	..	
	118	
At a cost per head per week of	..	..
The cost for the whole year is	..	..
8. FUNERALS AND EXTRA CHARGES.		
Funerals, Fees, Tolling Bell &c.	..	
Coffins	..	
Shrouds	..	
Removals of Patients	..	
	27	
9. PATIENTS IN OTHER ASYLUMS.		
For maintenance of Patients	..	
in Stone Asylum	..	
Ditto in Bethnal House Asylum	..	
Ditto in Worcester Asylum	..	
Ditto in Dorset Asylum	..	

PAYMENTS.

38

	First Quarter 31st March.	Second Quarter 30th June.	Third Quarter 30th Sept.	Fourth Quarter 31st December.	For the year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Brought forward					9699 18 6
(6.) Clothing.					
Boots and Shoes	.. ..	.. ..	.. ..	.. ..	69 9 7
Bonnets (straw)	.. ..	.. ..	.. ..	.. ..	.. ..
Buttons	9 0 0	.. ..	.. ..	.. ..	.. ..
Calico (colored)	8 3 10½	.. ..	.. ..	.. ..	.. ..
Ditto (blue)	.. ..	587½ yards 7½d	18 19 5	.. ..	.. ..
Ditto (shirting)	.. ..	590 yards 7½d	18 8 9	.. ..	.. ..
Ditto (ditto stout)	.. ..	893½ yards 6½d	23 5 4½	.. ..	.. ..
Ditto (unbleached)	.. ..	1154 yards 7½d	35 9 2½	.. ..	.. ..
Ditto (ditto stout)	.. ..	300 yards 5½d	7 3 9	.. ..	.. ..
Caps (women's)	.. ..	1500 yards 7½d	46 1 10	.. ..	.. ..
Cloth (men's grey)	630½ yards 6½d	193 1 10	.. ..	.. ..	.. ..
Ditto (men's striped tweed)	.. ..	254½ yards 5½d	71 16 10	.. ..	.. ..
Ditto (men's steel ditto)	.. ..	256½ yards 5½d	72 8 2	.. ..	.. ..
Ditto for a suit of clothes	.. ..	.. ..	.. ..	.. ..	.. ..
Cotton (reel)	3 12 9	.. ..	.. ..	.. ..	3 12 0
Ditto (darning)	17 8 0	.. ..	.. ..	.. ..	.. ..
Forfar (stout)	.. ..	366 yards 7½d	11 16 4½	.. ..	.. ..
Ditto (towelling)	.. ..	244½ yards 7½d	7 7 8½	.. ..	.. ..
Ditto (wrapping)	.. ..	.. ..	2 13 0	0 7 6	0 6 6
Flannel (Welsh)	2 5 6	.. ..	.. ..	.. ..	.. ..
Handkerchiefs (men's)	.. ..	582 yards 12½d	30 18 4½	.. ..	.. ..
Ditto (women's)	.. ..	36 dozen 3/10	6 18 0	.. ..	.. ..
Hats (felt)	.. ..	24 dozen 4/4	5 4 0	.. ..	.. ..
Laces (boot)	8 8 0	.. ..	8 14 0	.. ..	9 0 0
Ditto (stay)	3 0 0	.. ..	.. ..	.. ..	.. ..
Leather & Materials for Shoes	1 12 0	.. ..	2 11 0	.. ..	2 11 0
Linen check	30 18 11	.. ..	31 11 0	.. ..	33 0 11
Ditto (tickling)	.. ..	467½ yards 10½d	20 13 11	.. ..	.. ..
Neckerchiefs (men's)	.. ..	330½ yards 1/4½	22 14 5	.. ..	.. ..
Stockings (men's worsted)	.. ..	54 10-12 dozen 6/4½	17 9 7	.. ..	.. ..
Ditto (men's cotton)	.. ..	24 dozen 21/3	25 10 0	.. ..	.. ..
Ditto (women's ditto)	.. ..	12 dozen 14/11	8 19 0	.. ..	.. ..
Shoemaker	.. ..	24 dozen 9/3	11 2 0	.. ..	.. ..
Tailor	21 9 0	.. ..	23 6 6	24 7 6	14 8 0
Tape (brown)	24 8 0	.. ..	26 5 0	29 0 0	26 15 6
Ditto (white)	8 3 0	.. ..	.. ..	.. ..	.. ..
Twill	5 18 10	.. ..	.. ..	.. ..	.. ..
Worsted	4 2 2	.. ..	.. ..	.. ..	.. ..
Thread, Needles, &c.	7 2 0	.. ..	.. ..	.. ..	.. ..
	19 7 8	.. ..	0 12 0	.. ..	9 5 0
	377 19 6½	526 8 2½	97 0 0	168 8 6	1169 16 3
At a cost per head per week of	0 1 2½ 52	0 1 8½ 94	0 0 03½ 46	0 0 6½ 37	
The cost for the whole year is	0 0 11½ 07 per head per week.				
Carried forward					£10869 14 9

PAYMENTS.

39

	1st Quarter 31st March.	2nd Quarter 30th June.	3rd Quarter 30th Sept.	4th Quarter 31st Dec.	For the Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Brought forward					10869 14 9
7. FURNITURE					
Baskets	4 18 0	2 7 3	10 14 10	6 14 0	
Blankets .....	.. ..	75 1 6	.. ..	.. ..	
Chairs (Windsor) .....	.. ..	.. ..	4 4 0	.. ..	
Chamber Ware of Gutta Percha	23 11 6	.. ..	.. ..	.. ..	
Clothes lines .....	.. ..	2 15 0	.. ..	.. ..	
Combs and Brushes	8 14 0	6 6 0	6 6 0	6 6 0	
Crockery	13 4 6	7 11 11	7 1 6	12 3 10	
Culinary utensils, Brushes, Mops, &c.	21 10 6	16 7 0	20 2 6	21 15 2	
Cutlery repairs	0 18 0	0 18 8	0 12 8	1 0 0	
Dowels for sheets .....	.. ..	91 6 9	.. ..	.. ..	
Huckaback for Table Cloths .....	.. ..	16 0 5	.. ..	.. ..	
Horse-hair for Mattresses	34 6 0	.. ..	.. ..	.. ..	
Lamps and Lanterns .....	.. ..	.. ..	.. ..	4 7 0	
Mats	1 3 4	.. ..	5 6 6	.. ..	
Pails .....	.. ..	.. ..	7 6 0	.. ..	
Razors .....	.. ..	1 2 0	.. ..	.. ..	
Razor-strops .....	.. ..	.. ..	1 8 0	.. ..	
Sackings .....	.. ..	.. ..	3 0 0	.. ..	
Shoe-brushes	4 4 0	.. ..	.. ..	.. ..	
Spectacles	3 10 0	.. ..	.. ..	.. ..	
Sponge .....	.. ..	.. ..	.. ..	3 17 0	
Ticking for Mattresses .....	.. ..	41 5 0	.. ..	.. ..	
Tin baking dishes .....	.. ..	.. ..	.. ..	7 0 0	
Tin cans .....	.. ..	.. ..	5 2 6	.. ..	
Twine	2 8 2	.. ..	.. ..	.. ..	
Upholsterer .....	.. ..	.. ..	7 1 5	14 7 2	
Ward Whistles and rings .....	.. ..	.. ..	1 17 0	.. ..	
	118 8 0	261 1 6	80 2 11	77 10 2	537 2 7
At a cost per head per week of	0 0 4 64	0 0 10 13	0 0 3 77	0 0 3 13	
The cost for the whole year is	0 0 5 116	per head	per week.		
8. FUNERALS AND EXTRA CHARGES.					
Funerals, Fees, Tolling Bell &c.	3 14 6	4 12 6	0 18 0	4 8 0	
Coffins	9 9 0	.. ..	.. ..	9 9 0	
Shrouds	14 0 4	.. ..	.. ..	.. ..	
Removals of Patients .....	.. ..	1 13 6	.. ..	5 2 1	
	27 3 10	6 6 0	0 18 0	18 19 1	53 6 11
9. PATIENTS IN OTHER ASYLUMS.					
For maintenance of Patients					
in Stone Asylum	61 15 0	61 15 0	49 15 11	44 7 3	
Ditto in Bethnal House	177 2 6	169 12 11	.. ..	163 10 10	
Asylum	183 4 7	185 5 0	192 5 0	192 5 0	
Ditto in Worcester Asylum .....	.. ..	.. ..	.. ..	584 17 2	
Ditto in Dorset Asylum	422 2 1	416 12 11	242 0 11	985 0 2	2065 16 2
Carried forward					£13,526 0 5

PAYMENTS.

40

	1st Quarter 31st March.	2nd Quarter 30th June.	3rd Quarter 30th Sept.	4th Quarter 31st Dec.	For the Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Brought forward					13,526 0 5
10. REPAIRS					
Clerk of the works	13 13 0	13 13 0	13 13 0	13 13 0	
Carpenter	12 0 10	13 0 0	14 2 6	12 19 2	
Mason	14 13 4	14 14 3	17 15 8	14 12 5	
Laborers	8 7 6	9 5 6	10 9 4	8 14 9	
	48 14 8	50 12 9	56 0 6	49 19 4	205 7 3
At a cost per head per week of	0 0 1 67	0 0 1 97	0 0 2 93	0 0 2 93	
The cost for the whole year is	0 0 2 09	per head per week.			
11. GARDEN EXPENSES.					
Gardener	12 0 0	13 0 0	14 0 0	13 0 0	
Laborers	36 2 0	37 10 6	34 0 6	39 11 6	
Seeds	2 17 2	.. ..	.. ..	1 6 0	
Tools .....	.. ..	9 10 3	1 1 0	.. ..	
Payments on Live Stock					
Account	1 0 3	0 12 9	0 5 6	1 2 9	
Straw, Beans, Barley, &c. ..	28 6 0	19 8 0	24 14 0	38 18 0	
	80 5 5	80 1 6	83 1 0	93 18 3	337 6 2
At a cost per head per week of	0 0 3 64	0 0 3 62	0 0 3 24	0 0 3 70	
The cost for the whole year is	0 0 3 29	per head per week.			
12. RATES, TAXES AND INSURANCE.					
Rates and Taxes	2 15 4	6 11 11	.. ..	6 3 9	
Insurance	16 7 9	.. ..	.. ..	.. ..	
	19 3 1	6 11 11	.. ..	6 3 9	31 18 9
At a cost per head per week of	0 0 0 01	0 0 0 03	.. ..	0 0 0 96	
The cost for the whole year is	0 0 0 25	per head per week.			
13. MISCELLANEOUS.					
Advertisements, Printing,					
Postage and Stationary ..	67 5 9	35 6 2	41 3 3	68 16 0	
Carriage of Parcels	1 6 11	0 14 0	0 4 8	0 16 7	
Escape Expenses .....	.. ..	.. ..	1 12 8	.. ..	
Expenses of Enquiries at					
other Asylums	3 3 0	1 10 0	1 4 0	.. ..	
	71 15 8	37 10 2	44 4 7	69 12 7	223 3 0
At a cost per head per week of	0 0 2 30	0 0 1 90	0 0 1 05	0 0 2 190	
The cost for the whole year is	0 0 2 78	pre head per week			
Cash in the hands of House Steward					190 14 10
Balance in the hands of Treasurer					1451 12 1
					£15,966 2 6

PAYMENTS.

	1st Quarter 31st March.	2nd Quarter 30th June
	£ s. d.	£ s. d.
Brought forward		
10. REPAIRS		
Clerk of the works	13 13 0	13 13
Carpenter	13 0 10	13 0
Mason	14 13 4	14 14
Laborers	8 7 6	9 5
	48 14 8	50 12
At a cost per head per week of	0 0 1367	0 0 1
The cost for the whole year is	0 0 209	per head
11. GARDEN EXPENSES.		
Gardener	12 0 0	13 0
Laborers	36 2 0	37 10
Seeds	2 17 2	..
Tools	..	9 10
Payments on Live Stock		
Account	1 0 3	0 12
Straw, Beans, Barley, &c. ..	23 6 0	19 8
	80 5 5	80 1
At a cost per head per week of	0 0 3 64	0 0 3
The cost for the whole year is	0 0 3 29	per head
12. RATES, TAXES AND INSURANCE.		
Rates and Taxes	2 15 4	6 11 1
Insurance	16 7 9	..
	19 3 1	6 11 1
At a cost per head per week of	0 0 0 101	0 0 0
The cost for the whole year	0 0 0 25	per head
13. MISCELLANEOUS.		
Advertisements, Printing, Postage and Stationary ...	67 5 9	35 6
Carriage of Parcels	1 6 11	0 14
Escape Expenses	..	..
Expenses of Enquiries at other Asylums	3 3 0	1 10
	71 15 8	37 10
At a cost per head per week of	0 0 2 130	0 0 1
The cost for the whole year is	0 0 2 78	per head
Cash in the hands of House Steward		
Balance in the hands of Treasurer		

SUMMARY OF THE COST PER HEAD PER WEEK IN 1865.

	1st Quarter 31st March.	2nd Quarter 30th June.	3rd Quarter 30th Sept.	4th Quarter 31st Dec.	The Year.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Salaries and Wages. -	8, 79	8, 03	8, 90	8, 31	8, 25
Provisions -	6, 55	10, 65	11, 70	1, 97	10, 71
Wine, Spirits, and Porter -	4, 81	1, 37	2, 17	1, 05	3, 60
Necessaries -	11, 93	1, 04	2, 35	10, 00	3, 10
Surgery and Dispensary -	1, 84	8, 94	3, 91	3, 39	3, 03
Clothing -	2, 52	3, 94	3, 46	6, 37	11, 07
Furniture -	4, 64	10, 13	3, 77	3, 13	5, 16
Repairs -	1, 67	1, 97	2, 93	1, 82	2, 09
Garden Expenses -	3, 64	3, 61	3, 24	3, 70	3, 29
Rates, Taxes and Insurance -	3, 01	1, 03	1, 05	2, 96	2, 25
Miscellaneous -	2, 30	1, 90	1, 05	2, 90	2, 78
Less Receipts from Sale of Produce, Labor &c. -	8, 86	10, 62	10, 48	3, 60	0, 33
Total -	2, 25	1, 29	2, 49	4, 36	2, 47
Average number of Patients	9	10	10	9	10
Aggregate Days of Residence	6, 61	9, 33	4, 58	4, 66	4, 66
	474	468	458	429	170, 379

BALANCE SHEET 1865.

RECEIPTS.		PAYMENTS.	
	£ s. d.		£ s. d.
Balance in the hands of Treasurer at the end of last year -		1 Salaries and Wages -	- - - 2085 17 3
Cash in the hands of the House Steward -	138 9	2 Provisions -	- - - 5925 18 10
		3 Wine, Spirits, and Porter -	- - - 91 9 0
		4 Necessaries -	- - - 1545 10 10½
From Sale of Produce &c. -	76 5	5 Surgery and Dispensary -	- - - 1545 12 6
For Maintenance of Patients. -	215 14	6 Clothing -	- - - 51 12 6
	143 10 11	7 Furniture -	- - - 1169 16 3
For Extra Charges -	55 2	8 Extra Charges and Funerals -	- - - 537 2 7
		9 Patients in other Asylums -	- - - 53 6 11
		10 Repairs -	- - - 2085 16 2
		11 Garden Expenses -	- - - 205 7 3
		12 Rates, Taxes and Insurance -	- - - 337 6 2
		13 Miscellaneous -	- - - 31 18 9
		Cash in the hands of House Steward -	- - - 223 3 0
		Balance in the hands of Treasurer -	- - - 190 14 10
			145 12 1
			£ 15,966 2 6

COMPARATIVE PRICES OF PROVISIONS, &c.

[illegible]

Made in the Asylum in 1865.

BY THE TAILOR AND MALE PATIENTS.

BY THE TAILOR AND MALE PATIENTS.		Brought forward	
Mattresses (sicking) re-made	51	Sheets	340
Pillows (ditto) re-made	53	Milowcases	39
Caps (cloth)	21	Ditto (Epileptic)	63
Jackets (ditto)	182	Caps (day)	10
Waistcoats (ditto)	190	Ditto (night)	514
Trousers (ditto)	207	Clothes (ditto)	499
Drawers (ditto)	21	Ditto (Flannel)	11
Frocks (ditto)	11	Drawers (calico)	11
	847	Ditto (flannel)	11
		Ditto (sickday)	11
		Frocks (mock)	77
		Gowns (night)	51
		Ditto (calico)	17
		Ditto (linen)	11
		Ditto (sicking)	11
		Neckerchiefs (banned)	11
		Handkerchiefs	191
		27 Shirts	310
Coverlets (sicking)	29	Ditto (flannel)	70
Ditto (ditto) remade	55	Shirts	11
Mattresses (ditto)	25	Bath towels	11
Caps (cloth)	205	Shawls	11
Pillows (ditto) ditto	78	Chamber dress	11
Ditto (Epileptic)	7	Tail coats	11
Ditto (ditto) re-made	49		
	545		

BY WARD ATTENDANTS AND
FEMALE PATIENTS.

Coverlids (ticking)	29
Ditto (ditto) remade	72
Mattresses (ditto)	25
Ditto (ditto) re-made	205
Pillows (ditto) ditto	87
Ditto (Epileptic)	78
Ditto (ditto) re-made	49

	£	s.	d.		£	s.	d.
To Store January 1865	245	0	0	By Consumption of 1865	250	19	0
Vegetable Produce of 1865	342	15	7	Sales of 1865	74	6	7
				Store December 31st 1865	262	10	0
	£587	15	7		587	15	7
Excess of Produce over Outlay.	£	s.	d.	Consumption 1861	16	7	
				Produce	£	s.	d.
To Live Stock at the beginning of the year	67	11	0	By Vegetables	342	15	7
Seeds, Labour and Tools	222	18	11	Sale of Live Stock	110	17	8
Payments on Live Stock Account, Straw, Beans, Barley, &c.	114	7	3	Value of ditto consumed	138	19	2
				Live Stock on hand, at the end of the year	52	10	0
					645	2	5
					404	17	5
	404	17	2	Balance in favor of Produce	£240	5	3
This Balance is—					£	s.	d.
Profit on Garden Account					119	16	8
Profit on Live Stock Account					120	8	7
					£240	5	3

J. J. ANDREWS

House Steward and Clerk of the Asylum.

OBSERVATIONS
ON THE
EFFECT OF COFFEE
ON THE
UREA AND CHLORIDES IN HEALTH.

BY
CHARLES E. SQUAREY, M.R.C.S.,
RESIDENT MEDICAL OFFICER TO THE LONDON FEVER HOSPITAL; LATE
PHYSICIAN'S ASSISTANT AT UNIVERSITY COLLEGE HOSPITAL.

COMMUNICATED BY
A. B. GARROD, M.D., F.R.S.

[From Volume XLIX of the 'Medico-Chirurgical Transactions,'
published by the Royal Medical and Chirurgical Society of
London.]

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1866.

OBSERVATIONS
ON THE
EFFECT OF COFFEE ON THE UREA AND
CHLORIDES IN HEALTH.

BY
CHARLES E. SQUAREY, M.R.C.S.,
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COMMUNICATED BY
A. B. GARROD, M.D., F.R.S.

Received Oct. 12th.—Read Nov. 14th, 1865.

I was induced to make these observations from a discussion which occurred, whilst I was doing duty at the Fever Hospital, as to the effect of coffee in the treatment of typhus fever, and in which doubts were expressed as to the truth of the observations of Lehmann and Böcker.

My observations were made whilst I was living at University College Hospital as physician's assistant, so that I had great opportunities for making them carefully.

To Dr. Russell Reynolds my best thanks are due for his kindness in permitting me to carry them out on patients admitted under his charge.

The experiments were made on three cases: two were patients, the third was myself.

The urine was collected every morning at 8 a.m., and

examined the same day, for urea, and latterly for chlorides. Both analyses were made by Liebig's volumetric method. In analysing the urea the chlorides were not separated, but two cubic centimetres of the test solution used for urea were subtracted, the same as is usually allowed.

During the time the analyses were being made, the patients were kept on a stated diet, the ordinary diet of hospitals, consisting of bread, 16 oz.; mutton (roast), 12 oz.; potatoes every other day; milk, $\frac{1}{2}$ pint; beer, 1 pint; with occasionally some beef-tea. My own diet was kept as much the same as possible—beefsteaks and mutton chops being the only meat taken. No stimulants of any kind were used during the whole experiments, milk and water being the chief drinks when not taking the coffee.

The same exercise as nearly as possible was taken both by the patients and myself.

The coffee was taken three times daily, at first in $\frac{1}{4}$ -oz. doses, and then increased, till at one time I was taking from 4 to 6 oz. daily. Above each table the amount of coffee, and how it was taken, are placed.

The temperature in the cases of the two patients was taken night and morning, and the ranges will be noted when reviewing the state of the patient during each week of coffee and non-coffee taking.

CASE 1.—George Plater, æt. 19, by occupation a wheelwright, was admitted into University College Hospital, January 29th, 1864, with symptoms of slight consolidation at the apex of the lung. For four months before admission he had been suffering from hæmoptysis, but it was never at any time copious; at present he coughs little, and the expectoration consists of about six little pellets, of faint yellow or pinkish colour, here and there streaked with blood.

At the commencement of the observations (Feb. 14th) the hæmoptysis had ceased; his weight was 105 lb., or 48 kilogrammes.

The lung symptoms were the same as on admission; there was no sign of any fresh deposition of tubercle.

Throughout the whole course of the observations the patient's health has continued good; he has, in fact, expressed himself as getting better and stronger every day. His temperature noted night and morning has been normal throughout, ranging between 97° and 99° Fahr.

During the first week, from February 14th to February 22nd, no coffee was taken.

2nd week.—On February 22nd, a decoction of coffee was made, by boiling 2 oz. of the powdered bean in 8 oz. of water, and allowed to cool in a stoppered bottle: 1 oz. of this, with the dregs, was taken three times daily from the 22nd to the 28th inclusive. His weight on the 28th was 110 lb., or 50 kilogrammes.

During the third week, from February 29th to March 6th inclusive, no coffee was taken.

4th and 5th weeks.—On March 7th, the patient began to take coffee again, and continued doing so till the 21st: $\frac{1}{4}$ -oz. doses were taken three times daily; but this time the freshly powdered bean was made into an infusion with boiling water, and milk and sugar being added *ad libitum*, dregs and all were swallowed hot. His weight on the 17th was 114 lb., or 52 kilogrammes.

During the 6th week, from March 21st to March 28th inclusive, no coffee was taken.

On the 30th, the patient left the hospital, feeling quite well.

CASE 2.—John Taylor, æt. 17, was admitted into University College Hospital, March 17th, 1864, suffering from an attack of subacute rheumatism. The temperature only once rose to 100° Fahr. throughout the attack; there was no pericarditis, but some old endocardial murmurs.

The observations in this case only last one week, owing to an attack of tonsillitis supervening, and the patient leaving the hospital immediately on recovery.

The observations were commenced on April 4th, and continued till April 11th. Throughout the week his health was good; he had no pain or stiffness in any of his joints, and his appetite was very good.

The coffee was taken three times a day in $\frac{1}{4}$ -oz. doses, an infusion being made as in the last case, and dregs and all swallowed hot with milk and sugar. The temperature noted night and morning ranged between 97° and 99° Fahr. Patient's weight on the 12th was 115 lb., or rather more than 52 kilogrammes.

CASE 3.—The third series of observations were made on myself, and extended over a longer period than either of the others. At the time of making them my health was good in every respect; weight was 140 lb., or 64 kilogrammes.

The observations commenced on February 15th; during the first week, from February 15th to February 22nd, no coffee was taken.

Diet.—Breakfast, 8 a.m., eggs, bread and butter, milk. Lunch, 1 p.m., bread and butter, water. Dinner, 5 p.m., beefsteaks, vegetables, pastry, and water; and generally, about 8 p.m., some milk, with some bread and butter.

2nd week.—From 22nd to 28th of February, coffee was taken three times a day—at breakfast, lunch, and dinner; three breakfast-cups of a strong infusion at each meal, with milk and sugar. The diet was the same; health good.

3rd week.—From February 29th to March 6th inclusive, no coffee was taken; mutton chops were substituted for beefsteaks at dinner—otherwise the diet was the same; health good.

4th and 5th weeks.—From March 7th to March 20th inclusive, coffee was taken three times daily in $\frac{1}{4}$ -oz. doses. It was made into an infusion as in the first case, and milk and sugar being added, the dregs and all were swallowed. The diet was the same as in the last week; the stools were of a rather dark colour from the coffee-grains swallowed; health good.

6th week.—From March 21st to March 27th inclusive, no coffee was taken; beefsteaks were substituted for chops at dinner—the diet was otherwise the same.

7th and 8th weeks.—From March 28th to March 31st, $\frac{1}{4}$ -oz. doses of coffee were taken twice daily, an infusion being

made and taken in the same way as in previous weeks. Not feeling very well on April 1st, I left off taking coffee till the 4th, when I again took $\frac{1}{4}$ -oz. doses of coffee three times a day. An infusion was made, and the dregs swallowed as before; the diet was the same as in the last week; stools were very costive and dark-coloured; the urine of April 10th was lost; no coffee was taken.

9th week.—On the 11th and 12th of April, $\frac{1}{4}$ -oz. doses of coffee were taken three times daily; on the 13th and 14th, 1-oz. doses were taken twice daily; on the 15th and 16th, 2-oz. doses were taken three times daily; but finding that the large amount of coffee-grains swallowed very much impaired my appetite, the coffee was the last four days boiled in water, strained, and then taken with milk and water. Health was pretty good; urine of 16th and 17th of April was lost.

10th week.—On the 18th the coffee was left off, and none taken since. The urine was examined till the 25th of April; health this week better; appetite improved.

Conclusions.—In the first case, the patient, G. Plater, was throughout the observations gaining strength and weight, and the analyses show a regular increase in the amount of urea excreted.

On comparing corresponding coffee and non-coffee weeks, no appreciable difference is to be found. The greatest is in the first (non-coffee) week and the second (coffee) week; the daily average in the second week, when $\frac{1}{4}$ -oz. doses of coffee were being taken three times daily, being 2.198 grammes more than in the first week, when no coffee was taken.

In the third (non-coffee) and fourth (coffee) weeks, the daily average was slightly less in the latter, when $\frac{1}{4}$ -oz. doses were taken three times a day. The difference, however, was only .424 of a gramme; and, again, in the fifth week, when the coffee was taken the same as in the fourth week, the average per day was more by .515 of a gramme than in the sixth week, when no coffee was taken.

Daily average of Urea excreted per kilogramme of Body-weight.

NON-COFFEE WEEKS.		COFFEE WEEKS.	
In the first week	= 355 grammes.	In the second week	= 385 grammes.
third week	= 450 "	fourth week	= 440 "
sixth week	= 460 "	fifth week	= 470 "

In the second case, John Taylor, *et. 17*, weight 115 lb., or 52 kilogrammes, owing to an attack of tonsillitis supervening in the middle of the observations, and the patient leaving immediately on recovery, the effect of coffee on the urea can only be estimated by comparing the amount passed per kilogramme of body-weight during the observations with the normal amount in health. Patient passed on the average $\cdot 428$ of a gramme of urea per kilogramme; he was taking $\frac{1}{4}$ -oz. doses of coffee three times daily.

In the third series of observations, made on myself, we find, on comparing the analyses of corresponding weeks, that in the first (non-coffee) and in the second (coffee) weeks, the daily average was rather greater in the latter, when three cups of a strong infusion of coffee were taken three times a day; it being 34.080 grammes in the second week, to 33.099 grammes in the first week.

In the third and fourth weeks, the excess was in the non-coffee week, the daily average in the third week, when no coffee was taken, being 36.281 grammes, and in the fourth week, when $\frac{1}{4}$ -oz. doses of coffee were taken three times a day, only 31.182 grammes; thus less in the coffee-taking week by 5.099 grammes: yet in the next (fifth) week, the same amount of coffee being taken, the daily average rose to 33.705 grammes; and, again, in the following (sixth) week, no coffee being taken, the daily average fell to 32.962 grammes, less by $\cdot 743$ of a gramme than in the previous coffee-taking week.

During the seventh week, the amount of coffee was increased to $\frac{1}{2}$ oz. twice daily; in the three days during which

the urine was examined, the daily average was 34.210 grammes.

In the eighth week, $\frac{1}{4}$ -oz. doses of coffee were taken three times daily; yet there was rather an increase than a diminution in the amount of urea excreted, 34.375 being the daily average.

Up to this time the coffee-grains had been swallowed in the infusion at each dose; but the large amount of solid matter thus introduced into the stomach materially affected the appetite, which now was not so good as it had previously been, and the effect on the stools was to render them very costive and almost black, so that in the next (ninth) week on increasing the dose to 1 oz. the grains were strained off.

9th week.—On the 11th and 12th of April, $\frac{1}{4}$ -oz. doses were taken three times daily; on the 13th and 14th of April, 1-oz. doses were taken three times daily; on the 15th and 16th of April, 2-oz. doses were taken three times daily. The result was that the daily average of urea fell to 32.291 grammes, which, however, was not less than in the sixth week, when no coffee was taken.

During the tenth week no coffee was taken, at the same time the diet was not so strict,—meat being taken as well as eggs for breakfast, and varied daily at dinner; and on referring to the notes, I find "felt much better—appetite better," entered daily. This week the average rose to 37.086 grammes per day, greater by 4.161 grammes than in the previous week.

Daily average of Urea excreted per kilogramme of Body-weight in each week.

NON-COFFEE WEEKS.		COFFEE WEEKS.	
In the first week	= 535 grammes.	In the second week	= 541 grammes.
second week	= 575 "	fourth week	= 495 "
third week	= 523 "	fifth week	= 535 "
tenth week	= 588 "	seventh week	= 543 "
		eighth week	= 545 "
		ninth week	= 524 "

These results, I think, show that coffee does not diminish

the excretion of urea in health by any appreciable amount when taken in the above doses. In fact, only in my own case has there been any diminution at all; whilst in the first case, G. Plater, there was an actual increase throughout the observations; and in the second case, John Taylor, the average was by no means below the normal amount.

It is very questionable whether the diminution in my own case was due to the coffee—firstly, because it did not recur regularly during each period of coffee-taking, and, secondly, it was not beyond the limits frequently noted in health.

The diminution only occurred twice, in the fourth week, when it was less by 5.099 grammes than in the preceding week, and in the ninth, when it was less by 4.161 grammes than in the tenth week; but it is hardly fair to take the latter into consideration, as during the ninth week I was not feeling well, and my appetite was not good, owing, no doubt, to the large amount of coffee that had been taken, and to the strictness of the diet, which, from February 15th till April 16th, had only been varied by substituting beefsteaks for mutton chops for dinner in alternate fortnights. In the tenth week, the diet being varied, my appetite improved, and, naturally, the daily excretion of urea increased.

2nd. The diminution is not beyond the limits frequently noted in health; for I find that Dr. Parkes, in his book on the Urine, says that "the maximum and minimum amounts passed in any one day by an individual are usually about 4th above and below his mean amount;" so that in my own case, passing on the average about 34 grammes daily, the diminution or increase of 6 grammes would in no way be abnormal. And again I find, on examination, that the difference between the maximum and minimum amounts in each week of coffee and non-coffee taking is, in the coffee weeks 6.883 grammes, and in the non-coffee weeks about 10.911 grammes, the former amount being even a greater difference than between any two weeks throughout the observations.

3rd. Throughout the whole course of the observations, the amount of urea excreted per kilogramme of body-weight was

only once below the normal amount, and then only by .005 of a gramme.

Chlorides.—In the first case, G. Plater, during the two weeks that coffee was taken in 4-oz. doses three times daily, the average was as nearly the same as possible as in the two corresponding weeks, when no coffee was taken; no increase or diminution worthy of remark, one way or the other.

Amount per kilogramme of Body-weight in each week.

COFFEE-TAKING WEEKS.		NON-COFFEE WEEKS.	
In the fourth week =	.14 grammes.	In the third week =	.14 grammes.
fifth week =	.152 "	sixth week =	.15 "

This, according to Dr. Parkes, would be at the normal rate.

As a last observation on the patient, I gave him, on March 28th, three 4-oz. doses of coffee, dregs swallowed: this gave him violent abdominal pains in the night, which, however, were soon relieved by hot fomentations. On the 29th he did not take any coffee.

Analysis of Urine for the two days.

	Amount of water			React.	Alb.	Urea.		Chlorides.
	C.C.	Sp. gr.				Grammes	Grammes.	
March 29. Coffee	2860	1006	Acid	None		22.880	31.460	
30. Non-Coffee ...	475	1027	"	"		21.285	1.485	

Here it will be seen that the water and the chlorides were largely increased, the chlorides amounting to .617 per kilogramme of body-weight; the urea remained normal.

On the next day, no coffee having been taken, the water was much lessened; the urea still remained normal, but the chlorides were reduced to .029 of a gramme per kilogramme of body-weight. Unfortunately, the patient left the hospital

the next day, so that this interesting point could not be followed up.

In the second case, J. Taylor, $\frac{1}{4}$ -oz. doses of coffee were given at once, with the hope that the same interesting result would follow as in the first case; but on referring to the table his daily average will be found to be not more than 8.444 grammes, or .162 gramme per kilogramme of body-weight—a rather large but certainly not abnormal amount for a boy of his age and weight.

In the third set of observations, as in the second, no definite result has been arrived at. The average is above the normal rate throughout.

Daily average per kilogramme of Body-weight in each week.

Non-Coffee Weeks.		Coffee Weeks.	
In the third week	= .226 grammes.	In the fourth week	= .203 grammes.
sixth week	= .221 "	fifth week	= .251 "
tenth week	= .202 "	seventh week	= .272 "
		eighth week	= .168 "
		ninth week	= .181 "

It was lowest in the eighth week, when $\frac{1}{4}$ -oz. doses were being taken three times daily, and highest in the seventh week, when $\frac{1}{4}$ -oz. doses of coffee were being taken twice daily.

In conclusion, I may say that neither the patients nor myself suffered in any way any ill effects from the coffee; not even when taking 1 and 2-oz. doses at a time did I suffer from any headache, giddiness, or unsteadiness of the hands: on the contrary, I always felt when taking it more lively and fit for work after meals.

The pulse, examined two or three times in the case of the patients, was found to be generally increased a few beats for about an hour after taking the coffee.

Analysis of Urine in First Case (G. PLATER).

First week.—Non-Coffee.

Date.	Amount of water.		Sp. gr.	React.	Alb.	Urea.		Chlorides.	
	C.C.	Oz.				Grms.	Grains.	Grms.	Grains.
15	725	25 $\frac{1}{2}$	...	Acid	None	15.765	240.20	...	...
16	735	26	...	"	"	15.162	231.97	...	...
17	Lost	...	...	"	"	...	...	...	...
18	1240	43 $\frac{1}{2}$	...	"	"	16.977	258.74	...	...
19	1290	45 $\frac{1}{2}$	...	"	"	16.846	257.72	...	...
20	1095	38 $\frac{1}{2}$	...	"	"	19.217	294.02	...	...
21	1350	47 $\frac{1}{2}$	...	"	"	17.350	265.45	...	...
22	1150	40 $\frac{1}{2}$	...	"	"	16.425	251.32	...	...
						Grammes.		Grains.	
Average per diem of urea						16.820		259.02	
Amount per kilogramme of body-weight						.355			

Second week.—Coffee taken ($\frac{1}{4}$ -ounce doses three times daily).

Date.	Amount of water.		Sp. gr.	React.	Alb.	Urea.		Chlorides.	
	C.C.	Oz.				Grms.	Grains.	Grms.	Grains.
23	1560	55	...	Acid	None	22.975	341.51	...	...
24	1750	61 $\frac{1}{2}$	...	"	"	18.230	278.51	...	...
25	1565	55	...	"	"	15.987	244.60	...	...
26	1065	37 $\frac{1}{2}$	...	"	"	18.032	275.88	...	...
27	655	23 $\frac{1}{2}$	...	"	"	21.417	327.08	...	...
28	1370	48	...	"	"	19.339	285.69	...	...
29	1165	41	...	"	"	17.167	262.65	...	...
						Grammes.		Grains.	
Average per diem of urea						19.018		292.97	
Amount per kilogramme of body-weight						.385			

Third week.—Non-Coffee.

Date.	Amount of water.					Urea.		Chlorides.	
March.	C.C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
1	965	34	...	Acid	None	23-170	356-81	6-082	93-66
2	Lost	...	...	...	...	...	...	...	...
3	1400	49½	...	...	...	21-940	337-87	7-060	108-72
4	860	30½	...	...	...	23-479	361-57	6-630	102-10
5	1195	42	...	...	...	23-160	356-63	7-108	109-46
6	1820	64	...	...	...	23-977	369-24	9-279	142-89
7	1195	42	...	...	...	17-742	273-22	6-875	105-87
						Grammes.	Grains.		
Average per diem of urea						22-244	or 342-5		
Amount per kilogramme of body-weight						45			
Average per diem of chlorides						7-172			
Amount per kilogramme of body-weight						14			

Fourth week.—Coffee taken (½-ounce doses three times daily, hot).

Date.	Amount of water.					Urea.		Chlorides.	
March.	C.C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
8	1495	52½	...	Acid	None	21-712	334-35	...	...
9	1355	47½	...	...	...	20-590	317-08	7-585	116-8
10	950	33½	...	...	...	18-039	277-90	6-407	98-6
11	1890	68½	...	...	...	20-730	391-64	10-293	158-0
12	1030	36½	...	...	...	23-335	362-42	6-355	97-8
13	1280	45	...	...	...	21-905	337-33	7-255	111-7
14	1300	45½	...	...	...	20-235	311-61	5-108	78-5
						Grammes.	Grains.		
Average per diem of urea						21-820	or 336-02		
Amount per kilogramme of body-weight						444			
Average per diem of chlorides						7-163	or 110-29		
Amount per kilogramme of body-weight						14			

Fifth week.—Coffee taken, same as last week.

Date.	Amount of water.					Urea.		Chlorides.	
March.	C.C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
15	1690	59½	...	Acid	None	24-340	374-8	8-055	124-0
16	1185	41½	...	...	...	22-097	340-2	6-698	103-1
17	1575	55½	...	...	...	25-145	387-2	7-986	122-9
18	1555	55½	...	...	...	24-707	380-4	7-007	109-2
19	1960	68	1015	...	...	24-480	376-9	6-463	99-5
20	2020	71	1011	...	...	28-280	435-5	11-110	171-0
21	1010	35½	1016	...	...	19-695	303-3	7-070	108-8
						Grammes.	Grains.		
Average per diem of urea						24-106	or 371-2		
Amount per kilogramme of body-weight						472			
Average per diem of chlorides						7-782	or 119-8		
Amount per kilogramme of body-weight						152			

Sixth week.—Non-Coffee.

Date.	Amount of water.					Urea.		Chlorides.	
March.	C.C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
22	1325	46½	1015	Acid	None	21-862	336-67	6-625	102-02
23	1295	45½	1010	...	...	16-835	259-25	6-475	98-91
24	1515	53½	1014	...	...	26-785	396-62	8-322	127-36
25	Lost	...	1016	...	...	...	...	...	...
26	1280	45	1016	...	...	24-960	384-98	7-680	118-27
27	1400	49½	1016	...	...	27-300	420-42	9-100	140-14
28	1155	40½	1017	...	...	24-832	382-41	6-852	97-82
						Grammes.	Grains.		
Average per diem of urea						23-591	or 363-3		
Amount per kilogramme of body-weight						463			
Average per diem of chlorides						7-426	or 114-36		
Amount per kilogramme of body-weight						15			

*Analysis of Urine in Second Case (J. TAYLOR).*Coffee taken three times daily, in $\frac{1}{4}$ -ounce doses.

Date.	Amount of water.					Urea.		Chlorides.	
April.	C. C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
5	1320	46½	1015	Acid	None	21·120	325·3	7·260	111·8
6	1410	49	1015	"	"	21·855	336·5	9·870	151·9
7	Lost	...	1025	"	"	...	...	...	...
8	1680	59	1015	"	"	26·940	401·0	9·000	138·5
9*	500?	17½	1024	"	"	13·250	...	3·250	...
10	Lost	...	...	"	"	...	...	...	...
11	1005	35	1016	"	"	20·602	317·2	8·040	123·8
12	1150	40½	1016	"	"	21·850	336·5	8·050	123·9
						Grammes.		Grains.	
Average per diem of urea						22·293		or 343·3	
Amount per kilogramme of body-weight						·428			
Average per diem of chlorides						8·444		or 130	
Amount per kilogramme of body-weight						·162			

* Man declared he had lost none, but still it is doubtful.

* Man declared he had lost none, but still it is doubtful.

Analysis of Urine in Third Case (C. E. S.).

First week.—Non-Coffee.

Date.	Amount of water.					Urea.		Chlorides.	
Feb.	C. C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
16	885	31	...	Acid	None	28·860	444·4	...	...
17	Lost	...	...	"	"	...	...	...	...
18	920	32½	...	"	"	31·855	490·5	...	...
19	1055	37	...	"	"	32·102	494·3	...	...
20	1055	37	...	"	"	37·105	571·4	...	...
21	1340	47	...	"	"	40·155	618·3	...	...
22	1120	39½	...	"	"	32·120	494·6	...	...
						Grammes.	Grains.		
Average per diem of urea						33·669	or 519·9		
Amount per kilogramme of body-weight						...	·535		

Second week.—Coffee taken (3 breakfast-cups of a strong infusion three times a day).

Date.	Amount of water.					Urea.		Chlorides.	
Feb.	C. C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
23	1075	37½	...	Acid	None	35·647	548·9	...	...
24	1445	50½	...	"	"	37·127	571·7	...	...
25	1515	53	...	"	"	32·983	507·9	...	...
26	1080	37½	...	"	"	33·683	518·1	...	...
27	870	31	...	"	"	29·812	459·1	...	...
28	740	26	...	"	"	31·547	485·8	...	...
29	1085	37½	...	"	"	37·765	581·5	...	...
						Grammes.	Grains.		
Average per diem of urea						34·080	or 524·8		
Amount per kilogramme of body-weight						...	·541		

Third week.—Non-Coffee.

Date.	Amount of water.					Urea.		Chlorides.	
March.	C. C.	Oz.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
1	Lost	...	...						
2	1060	37	...	Acid	None	44·454	685·0	13·283	204·5
3	Lost	...	...	"	"				
4	855	30½	...	"	"	33·155	510·5	13·775	212·1
5	880	31	...	"	"	34·160	526·0	13·960	214·9
6	965	34	...	"	"	34·935	572·9	14·255	219·5
7	1100	38½	...	"	"	34·700	534·0	15·880	244·5
						Grammes.	Grains.		
Average per diem of urea						36·281	or 558·7		
Amount per kilogramme of body-weight							·576		
Average per diem of chlorides							14·230	or 219·1	
Amount per kilogramme of body-weight							·226		

Fourth week.—Coffee taken (4-ounce doses three times daily—grains swallowed).

Date.	Amount of water.					Urea.		Chlorides.	
March.	C. C.	Qt.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
8	815	28½	...	Acid	None	30-560	470.6	...	...
9	965	35	...	"	"	34-140	525.7	13-637	210.0
10	875	31	...	"	"	29-137	448.7	12-435	191.3
11	1420	50	...	"	"	31-400	483.5	16-540	254.7
12	765	27	...	"	"	26-340	385.6	10-402	160.1
13	1045	37	...	"	"	34-917	537.7	14-297	230.1
14	940	33	...	"	"	29-780	458.6	9-580	147.5
						Grammes.		Grains.	
Average per diem of urea						31-182		or 480.2	
Amount per kilogramme of body-weight						485			
Average per diem of chlorides						12-813		or 197.3	
Amount per kilogramme of body-weight						203			

Fifth week.—Coffee taken (same way as in last week).

Date.	Amount of water.					Urea.		Chlorides.	
March.	C. C.	Qt.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
15	1080	37½	1031	Acid	None	36-270	558.3	15-470	238.2
16	965	33½	1030	"	"	35-647	548.9	14-207	218.7
17	1045	37	1028	"	"	32-555	501.3	15-252	234.8
18	1020	36	1030	"	"	33-812	520.7	16-087	248.7
19	885	31	1029	"	"	29-647	456.5	13-717	211.2
20	1225	43	1020	"	"	34-300	528.3	20-217	311.3
21	Lost	...	...	...	...	...	...	...	...
						Grammes.		Grains.	
Average per diem of urea						33-705		or 519	
Amount per kilogramme of body-weight						535			
Average per diem of chlorides						15-826		or 243.7	
Amount per kilogramme of body-weight						251			

Sixth week.—Non-Coffee.

Date.	Amount of water.					Urea.		Chlorides.	
March.	C. C.	Qt.	Sp. gr.	React.	Alb.	Grms.	Grains.	Grms.	Grains.
22	800	31	1030	Acid	None	30-260	466.0	13-795	212.4
23	1240	44	1025	"	"	37-820	582.4	14-260	219.6
24	885	31	1030	"	"	29-205	449.7	12-369	190.8
25	770	27	1029	"	"	29-260	450.6	9-635	148.2
26	1165	37½	1027	"	"	36-115	556.1	15-727	242.2
27	1305	46	1022	"	"	32-235	496.4	...	...
28	1280	45	1025	"	"	35-840	551.9	17-920	275.9
						Grammes.		Grains.	
Average per diem of urea						32-962		or 507.6	
Amount per kilogramme of body-weight						523			
Average per diem of chlorides						13-953		or 214.8	
Amount per kilogramme of body-weight						221			

Seventh week.—Coffee taken (4-ounce doses twice daily—grains swallowed).

Date.	Amount of water.					Urea.		Chlorides.						
March.	C.C.	Qt.	Sp. gr.	React.	Alb.	Grms.	Grains	Grms.	Grains					
29	1420	49½	1025	Acid	None	35.500	546.7	19.900	304.9					
30	1035	36	1029	"	"	31.567	486.1	14.490	223.1					
31	950	37	1030	"	"	35.575	547.8	...	...					
April 1 2 3	No coffee taken.					Not well.								
						Grammes.		Grains.						
Average per diem of urea						34.210		or 526.8						
Amount per kilogramme of body-weight						543								
Average per diem of chlorides						17.145		or 264.0						
Amount per kilogramme of body-weight						272								

Eighth week.—Coffee taken ($\frac{1}{4}$ -ounce doses three times daily, as in last week).

Date.	Amount of water.			React.	Alb.	Urea.		Chlorides.	
	C. C.	Oz.	Sp. gr.			Grms.	Grains.	Grms.	Grains.
April.									
5	890	31 $\frac{1}{2}$	1033	Acid	None	36.045	555.0	12.015	185.0
6	720	25	1033	"	"	30.960	476.7	6.840	105.3
7	705	24 $\frac{1}{2}$	1032	"	"	34.857	537.4	6.845	97.7
8	1300	44	1023	"	"	37.700	580.5	14.950	228.1
9	890	31 $\frac{1}{2}$	1029	"	"	34.710	534.3	12.905	198.7
10	875	31	1027	"	"	31.937	491.8	10.500	161.7
						Grammes.	Grains.		
Average per diem of urea						34.375	or 529.3		
Amount per kilogramme of body-weight						545			
Average per diem of chlorides						10.592	or 162.3		
Amount per kilogramme of body-weight						168			

Ninth week.—Coffee taken daily. (For quantity taken at each dose, see note of Case 3, ninth week.)

Date.	Amount of water.			React.	Alb.	Urea.		Chlorides.	
	C. C.	Oz.	Sp. gr.			Grms.	Grains.	Grms.	Grains.
April.									
12	765	27	1030	Acid	None	31.305	482.0	...	...
13	890	31 $\frac{1}{2}$	1031	"	"	34.295	527.6	...	...
14	920	32 $\frac{1}{2}$	1028	"	"	33.580	517.1	11.900	184.1
15	1000	35	1026	"	"	34.000	523.6	13.000	200.2
16	805	27	1030	"	"	31.395	483.4	9.257	142.7
						Grammes.	Grains.		
Average per diem of urea						32.921	or 507.1		
Amount per kilogramme of body-weight						524			
Average per diem of chlorides						11.405	or 175.6		
Amount per kilogramme of body-weight						181			

Tenth week.—Non-Coffee.

Date.	Amount of water.			React.	Alb.	Urea.		Chlorides.	
	C. C.	Oz.	Sp. gr.			Grms.	Grains.	Grms.	Grains.
April.									
*19	775	27 $\frac{1}{2}$	1027	Acid	None	30.225	465.5	8.912	137.2
20	1165	41	1027	"	"	40.775	627.9	16.310	251.1
21	1135	39 $\frac{1}{2}$	1025	"	"	36.320	559.3	17.025	262.1
22	1025	36	1027	"	"	34.850	536.6	16.360	251.9
23	1170	41	1030	"	"	44.660	687.7	16.380	252.2
24	860	30 $\frac{1}{2}$	1031	"	"	35.690	549.6	20.210	311.2
25	Lost	...	...	"	"	...	...	...	...
						Grammes.	Grains.		
Average per diem of urea						37.086	or 571.1		
Amount per kilogramme of body-weight						588			
Average per diem of chlorides						15.866	or 244.3		
Amount per kilogramme of body-weight						588			

ON
THE FOOD OF MAN
IN RELATION TO
HIS USEFUL WORK.

BY
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ON THE FOOD OF MAN IN RELATION TO HIS USEFUL WORK.

1. THE great generalization of Liebig, that food contains two chief classes of organic ingredients, one class consisting of nitrogenous substances, which give the plastic materials for the formation of tissues, while the other class contains the amylaceous and saccharine bodies destined to support the heat of the animal body, has met with general acceptance, notwithstanding the objections entertained by some physiologists to the general terms of the division. They state that the nitrogenous aliments may also support animal heat, as well as fulfil their special function of forming the tissues. But the distinguished author of the classification admitted this fact in his first work,¹ when he pointed out that the carnivora must waste their tissues in the support of animal heat. The recent experiments of Bischof and Voit,² and of Pettenkofer and Voit,³ in feeding animals on flesh from which all fat had been removed, completely prove that nitrogenous substances can act as heat-givers as well as flesh-formers. But the converse of the classification is not true, for we have not the

¹ Animal Chemistry, p. 120.

² Die Gesetze der Ernährung des Fleischfressers, p. 56, et seq.

³ Ann. der Ch. und Phar. Supp. Bd., 1863, p. 361, et seq.

slightest evidence to show that alimentary bodies free from nitrogen can build up any organ of the body. It is known that a small quantity of fat is always present in healthy tissue, but it may be wholly removed by ether without injury to the organic structure. The same experiments which proved that flesh-formers might when necessary act vicariously as heat-givers, have also proved that the nutrition of carnivora may be effected without the supply of fat or any other non-nitrogenous body.

2. The chief object of this lecture is to examine the function of nitrogenous ingredients of food, as a magazine of force for the production of dynamical effects in the animal. The consideration of the animal body as a machine, and of the food in the light of fuel supplied to it, has already engaged the attention of philosophers. Rumford,¹ Joule,² Mayer,³ Helmholtz,⁴ Dumas,⁵ Hirt,⁶ Fick,⁷ and Carpenter,⁸ have published their views on this important subject, but all of them, so far as I know their writings, have looked upon food in its aggregate, applying their calculations to the total carbon and hydrogen contained in it, without discussing the influence exerted by its separate constituents in the production of force.

3. The Rev. Dr. Haughton of Dublin has been an exception in this respect. He has endeavoured to find in the urine the representative of the mental, vital, and

¹ Rumford's Essays, vol. ii. p. 488.

² Joule and Scoresby, Phil. Mag. 1846, p. 454.

³ Mayer, Die organische Bewegung in ihrem Zusammenhang mit dem Stoffwechsel, 1845.

⁴ Helmholtz, Lectures at Royal Institution (Lect. vi.), 1864.

⁵ Dumas, as quoted by Matteucci, Phy. Phen. of Living Beings, p. 325.

⁶ Hirt, Théorie Mécanique de la Chaleur, p. 34.

⁷ Fick's Physiologie des Menschen, p. 291.

⁸ Carpenter's Jour. of Science, 1864, p. 266.

mechanical work of the human body, and gives the following equations:¹—

<i>Opus Mechanicum</i> , or 150 lbs. raised one mile,	}	= 136.5 grains of urea.
<i>Opus Mentale</i> , or five hours of study,		
	}	= 217.0 " "
<i>Opus Vitale</i> , . . .		
	}	= 297.0 " "

He then draws the conclusion that in manual or routine bodily labour, men are sufficiently well fed when they receive as much food as will discharge 400 grains of urea daily (the product of 2.8 oz. of flesh-formers), of which 300 grains are spent in vital work, and 100 grains (the product of less than three-fourths of an ounce of flesh-formers) in mechanical work. But when the work is of a higher order, Haughton states that a better quality of food must be supplied, sufficient to allow a discharge of 533 grains of urea daily, of which 300 grains are spent as before in vital work, and 233 grains in the mental and mechanical work necessary to keep the body in health.

4. If we are to understand these numbers of Haughton as being true exponents of the quantity of tissues necessary to be transformed for the production of force, the latter can readily be calculated and compared with that necessary to effect the work. Urea can only be an exponent of work, inasmuch as it shows us the quantity of tissue which has become oxidised in its production, and thus enables us to express the amount of energy stored up in that tissue, and in the oxygen which transformed it. Now, as 136.5 grains of urea are said to be equal to 150 lbs. weight raised to the height of one mile, we ought to find at least this amount of potential energy in

¹ Haughton on Healthy Urine of Man, p. 32.

the 405 grains of tissue from which the urea must have been derived, and in the oxygen required to convert it into this diamine. After deducting the hydrogen which may be supposed to have already met with oxygen in the tissues, we have available for transformation—

190.6	grains of carbon.
12.5	do. hydrogen.
5.1	do. sulphur.

These numbers, by the usual formula, would give 498.8 lbs. of water raised 1° Fah., and this, converted into its mechanical equivalent by the co-efficient 772, represents 385,073 lbs. raised to the height of one foot. This then represents the total potential energy, while the actual work realized by the man is more than double this amount, or is 792,000 foot-pounds. It is clear, then, that Haughton cannot have meant the equations given by him in the mathematical sense of equality, but only in the general sense of representation. In fact, in a further paper¹ he points out that the combustion of the carbon and hydrogen of the proteine compounds can only account for 54 per cent. (misprinted 34 per cent.) of the work ascribed to the urea. Hence we are obliged to class Haughton with the other writers, who consider that the transformation of the nitrogenous tissues is insufficient to account for the dynamical movements of the body.

5. In discussing this subject anew, I divide the work performed in the body as follows:—

1. Mental work.
2. Calorific work.
3. Internal dynamical work.
4. External do. do.
5. Digestive or assimilative work.

¹ Haughton on Diabetes Mellitus, p. 30.

With the two first divisions we have little to do in the present lecture; with the three last divisions we shall be fully occupied.

6. It will be convenient to proceed in the following order:—

DIVISION I.

- A. To ascertain the amount of food necessary for mere subsistence without exercise.
- B. To determine the amount of food required for complete health, with a moderate exercise of from five to seven miles daily.
- C. To fix the amount of food suited for active work, such as is represented by a man walking twenty miles daily continuously.
- D. To find the amount of food consumed by labourers with very arduous occupations, such as navvies engaged on railways.

Having ascertained these preliminary facts, which are altogether independent of theory, we shall then be in a position to proceed to

DIVISION II.

- A. To discuss whether there be sufficient potential energy in the nitrogenous tissues, or of the food representing them, and in the oxygen required for their transformation, to account for the dynamical actions within or without the body.
- B. To consider whether the fatty and amylaceous or saccharine ingredients of food are employed in this mechanical work.

Having discussed these points, we should then be in a position to proceed to

DIVISION III.

A. To inquire whether the secretions of urea and uric acid *per vesicam* are sufficient representatives of labour performed.

B. To consider what is represented by the nitrogenous materials secreted *per anum*.

DIVISION I.

Food required under different Conditions of Work.

7. In determining the amount of food required for mere subsistence, we ascertain, at least approximatively, that necessary for internal dynamical work. By that we mean such work as is carried on within the man independently of the will, and in the direction of which he is an unconscious agent. The heart beats, the blood circulates, the lungs play, the diaphragm acts, the intestines exert their peristaltic motion, by an inner directive movement. In the exercise of these motions a certain amount of force is expended, but it is ultimately converted into heat, and aids the *opus calorificum*, which is chiefly produced by the combustion of the non-nitrogenous parts of food.

In looking for a purely subsisting diet, we naturally turn to the experience of hospitals having convalescent patients unable still to take exercise. The following is the dietetic value in ounces of the "common diet with bread," employed at the Infirmary in Edinburgh.¹

¹ The ounce used in this lecture is always 437.5 grains, or 28.35 grammes, the gramme being taken at 15.43 grains.

Flesh-formers,	2.06 oz.
Fat,	0.58 "
Starch,	11.33 "
Starch equivalent of heat-givers, . .	12.69 "
Mineral matter,	0.35 "

In this diet the amount of carbon in the flesh-formers is 1.08 oz., and in the heat-givers 5.57, or together, 6.58 oz. This amount of carbon fairly represents that required to keep up the vital actions, for Dr. E. Smith¹ found, in his own case, that 6 oz. of carbon were exhaled by him during one day's starvation, and Ranke,² in a three days' trial, found 6.4 oz. every twenty-four hours. We may therefore assume that 6.5 oz. of carbon are required to support the life of an adult man without exercise. In the following Table are some recorded instances of deficient dietaries, although in some of the cases they were only defective because work was expected from the persons living upon them. They are therefore generally sufficient for mere subsistence during rest, but insufficient for the performance of labour.

An examination of the information furnished by this Table will justify the conclusion that though 2 oz. of flesh-formers, 0.5 oz. of fat, 12 oz. of starch and sugar, containing a total amount of 6½ oz. of carbon, will suffice for a man to support the internal dynamical motions and other vital necessities of his body when he is at complete rest, they are not compatible with a moderate amount of exercise; so that, even in the condition of low health without activity, 2.5 oz. of flesh-formers, 1 oz. of fat, 12 oz. of starch, and 0.5 oz. of mineral matter are necessary. This diet contains 7.44 oz. of carbon.

¹ Smith, Trans. Roy. Soc., vol. cxlix. p. 681.

² Ranke, Müller's Archiv. 1862, S. 342.

TABLE I.—SUBSISTENCE AND LOW DIETARIES.

DIETARIES.	Flesh-formers.	Fat.	Starch, etc.	Starch equiv.	Calen.
Contractors' insufficient prison diet, Bengal, ¹	2.05	0.73	17.84	19.58	9.583
Dundee Prison diet, treacle substituted for milk, 50% of prisoners lost weight, ²	2.87	0.87	13.41	15.41	8.168
Needlewomen in London, ³	1.90	1.04	10.29	12.74	6.292
"Common diet," Edinburgh Infirmary, ⁴	2.06	0.58	11.33	12.69	6.585
Average diet during cotton famine in Lancashire, 1862, ⁵	2.72	...	...	...	9.540
Diet of the prisoners in Libby Prison, Confederate States, ⁶	2.41	0.98	5.62	8.01	4.545
MEAN SUBSISTENCE DIET,	2.33	0.84	11.69	13.68	7.469

8. We have now to get a mean dietetic value for the food of an adult man in active health, but without hard labour. The dietaries of soldiers during peace offer us a large experience. I have recalculated the following Table, which was published formerly by me in a less complete form,⁷ taking bread as containing 37 per cent. of water.⁸ The data for the calculations have been obtained from the sources quoted below.

¹ Report of twenty-four Pergunnahs, 1847.

² Christison, Edin. Journ. Med. Soc. May 1852.

³ Rep. of Med. Officer of Privy Council, 1862.

⁴ Diet Tables of Edinburgh Infirmary, 1865.

⁵ Rep. Med. Off. Privy Council, 1865, p. 322.

⁶ Report of American Sanitary Commission, 1865.

⁷ Good Words, January 1865.

⁸ Lawes and Gilbert, Chem. Soc. Journ. x. 54.

TABLE II.—DIETARIES OF SOLDIERS DURING PEACE.

	Weight of Food.	Flesh-formers.	Fat.	Starch, Sugar, Coller, etc.	Starch, Sugar, Coller, etc.	Mineral Matter.	Carbon in Flesh-formers.	C ¹ Carbon in Flesh-formers.	C ² Carbon in Flesh-formers.	Total C + C ² .	Ratio of Total C to Starch 1 : x.	Ratio of Total C to Starch 1 : x.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
English soldiers, ¹	59.67	4.250	1.625	18.541	22.594	0.789	2.285	10.900	13.186	4.768	5.316	5.316
French soldiers, ²	48.6	4.406	1.431	19.142	22.579	0.700	2.370	9.600	11.970	4.050	5.124	5.124
Prussian soldiers, ³	55.0	3.995	1.105	19.472	22.124	0.724	2.149	9.496	11.645	4.418	5.537	5.537
Austrian soldiers, ⁴	40.75	4.210	1.389	17.606	20.940	0.645	2.264	8.886	11.150	3.924	4.973	4.973
MEAN DIETETIC VALUE,	51.0	4.215	1.347	18.690	22.059	0.714	2.267	9.720	11.987	4.290	5.237	5.237

The mean of this Table may fairly be taken as representing the value of food required to keep adult men in good health. According to the statements of surgeons⁵ in the army, the rations

¹ Parkes, Practical Hygiene, p. 144.

² Code des Officiers de Santé, 1862, p. 481.

³ Hildesheim, Die Normal Diet, p. 60.

⁴ Parkes, p. 148.

⁵ Dr. Buckland of the Guards, Soc. of Arts Journ. 1863.

of our own soldiers, which do not differ widely from the mean, are not sufficient for recruits during their drills, though the sergeants fatten upon them. As the average value is also nearly the same as that of middle class diets¹ we may safely assume it to be a correct expression of the diet of men who live well and take moderate exercise, of from five to seven miles daily.

9. Before we discuss the dietetic value of food required for men engaged in labour, we must define what we understand by a full day's work. We take such work, when performed continuously throughout the year, with rest on Sundays, to be represented by a daily walk of twenty miles. The experience of postmen in rural districts shows that more than this amount of work cannot be executed without the man breaking down. As the co-efficient of traction is nearly $\frac{1}{20}$ th the weight of a man's body, the work which a standard man of 150 lbs. has to perform is 792,000 foot-pounds. That this is a full estimate will be apparent from the following Table² of the work of a man under different conditions:—

Kind of Labour.	Amount of Work in ft. Tons.	Authority.
Pedestrians,	353	Haughton.
Pile-driving,	312	Coulomb.
" " " " " " " " " "	352	Lamare.
Turning a winch,	374	Coulomb.
Porters carrying goods and re- turning unloaded,	325	Coulomb.
Porters always loaded,	303	"
Porters carrying wood up stairs, descending unloaded,	381	"
Paviours at work,	352	Haughton.
Prisoners at Shot Drill,	310	"

MEAN, 340.2 Tons = 105,605 metre kilogrammes.

¹ Good Words, Feby. 1865.

² Haughton on a New Theory of Muscular Action, p. 16.

The mean of this Table gives 762,048 foot-pounds. A man's labour differs within a tolerably wide range, according to the manner in which it is exerted, for while it may not exceed 480,000 foot-pounds in hammering, it may reach to 1,500,000 foot-pounds when pushing or pulling horizontally.¹ Hence the amount of 792,000 foot-pounds taken for a day's work, may be considered a full, though not an excessive amount.

This estimate receives further support when we examine the work performed by soldiers in war. In Sherman's famous march from Atlanta to Savannah, twelve miles daily were accomplished. In war, the Prussian army walks fourteen miles daily, resting every fourth day. In our Indian marches, twelve miles daily, with the same rest, is the rate of work allowed to the troops. Hence, if we take full war work as represented by fourteen miles' daily continuous marching, the soldiers being laden with sixty lbs. weight of accoutrements,² we have a full estimate of labour work. This is found by the following equation—

$$\left(\frac{150 + 60}{20}\right) \times 73920 = 776,160 \text{ foot-pounds.}$$

The weight of the man and of his accoutrements, divided by the co-efficient of traction, and multiplied by the number of feet traversed, thus leads us to a result rather less than that found for the pedestrian. The following Table gives the dietetic value for soldiers engaged in the arduous duties of war:—

¹ Ranken, Applied Mechanics, p. 610.

² Parkes Hygiene, p. 369.

TABLE III.—DIETARIES OF SOLDIERS DURING WAR.

COUNTRY.	Weight of Solid Food.	Flesh formers.	Fat.	Starch, Sugar, etc.	Starch Equivalents.	Mineral Matter.	C Carbon in Flesh formers.	C' Carbon in Flesh formers.	Total Carbon C+C'.	Ratio of Starch to Starch Equiv.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
England (Crimean War), ¹	41.05	4.53	2.05	16.00	20.88	0.61	2.43	8.68	11.11	3.57
" (Kafir War), ²	47.4	5.74	2.94	16.00	23.03	0.73	3.48	9.36	12.84	3.93
France (Crimean War), ³	59.75	6.49	3.59	21.37	29.90	0.90	3.49	12.25	15.74	3.51
Prussia (Schleswig War), ⁴	48.0	5.90	1.60	21.41	25.26	0.84	3.17	10.73	13.90	3.38
Austria (Italian War), ⁵	38.6	5.15	2.68	21.47	26.24	0.61	2.77	11.51	14.28	4.15
Russia (Crimean War), ⁶	42.6	4.39	2.54	14.55	20.37	0.65	2.68	8.41	11.09	3.13
Holland (Belgian War), ⁷	28.4	4.33	1.40	13.87	17.22	0.40	2.32	7.23	9.55	3.11
Federal Army, 1865, ⁸	57.2	5.60	2.48	17.70	23.46	0.80	3.01	9.76	12.77	3.24
Confederate Army, 1865, ⁹	50.0	5.95	2.56	18.96	25.03	0.71	3.20	10.38	13.58	3.24
MEAN OF WAR DIET.	46.0	5.41	2.41	17.92	23.48	0.68	2.90	9.81	12.71	3.37

¹ Report of Sanitary Commission on the State of the Army, p. 427.

² Des Premiers, *Militaire Med.*, 1862.

³ Des Premiers, *Militaire Med.*, 1862.

⁴ Des Premiers, *Militaire Med.*, 1862.

⁵ Des Premiers, *Militaire Med.*, 1862.

⁶ Des Premiers, *Militaire Med.*, 1862.

⁷ Des Premiers, *Militaire Med.*, 1862.

⁸ Des Premiers, *Militaire Med.*, 1862.

⁹ Des Premiers, *Militaire Med.*, 1862.

¹⁰ Rep. San. Com. p. 425.

¹¹ Muller's *Ernährung*, p. 58.

¹² Des Premiers, *Militaire Med.*, 1862.

¹³ Des Premiers, *Militaire Med.*, 1862.

¹⁴ Des Premiers, *Militaire Med.*, 1862.

Hence it will be observed that about 5.5 oz. of flesh-formers, and 23½ oz. of the starch equivalent of heat-givers, are required by the soldier to enable him to withstand the fatigues of war.

10. We possess in the English army a corps of soldiers who are labourers even during peace. I allude to the Royal Engineers, who, while in the depôt at Chatham, are actively occupied either in constructing field-works, or in pursuing their avocations as artisans, from which class they are all selected. Desirous to obtain the dietaries of these men, I applied to Colonel Collinson, R.E., the second in command at Chatham, and he, with the consent of Colonel Harness, instituted a careful inquiry into the actual amount of food consumed by 495 men for twelve consecutive days. Quarter-Master Conolly took an active part in the inquiry, and the captains of each of the companies became responsible for the accuracy of the returns, which were made with all the detail and care to be expected from this highly scientific corps. These returns were then reduced to their dietetic value by myself, so that we may consider them as affording the most complete evidence which we possess of the requirements of food for labouring men during a fair but not an excessive amount of work in twenty-four hours.

TABLE IV.—DIETARIES OF THE ROYAL ENGINEERS FROM 1ST TO 12TH JANUARY 1865.

NAMES OF COMPANIES.	No. of Men giving returns.	Weight of solid food.	Flesh- formers.	Fat.	Sugar, etc.	Starch, Eggs, &c.	Mineral Matter.	C Carbon in Flesh- formers.	C Carbon in Heat- givers.	Total Carbon, C+C.	Ratio C:C+H.	Ratio of Flesh- formers to Starch Eggs, &c.
			oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
8th Company, . . .	30	68.6	5.37	2.68	22.46	29.37	0.90	2.889	12.257	15.146	4.24	5.47
23d " . . .	56	73.75	5.65	2.65	23.63	29.62	0.98	3.039	12.331	15.370	4.12	5.24
35th " . . .	90	64.22	4.84	2.94	20.24	29.24	0.83	2.603	11.250	13.853	4.32	6.04
36th " . . .	80	63.16	4.83	3.66	20.83	29.80	0.87	2.598	12.066	14.664	4.64	6.17
37th " . . .	67	68.2	5.39	2.64	22.70	29.31	0.87	2.899	12.111	15.010	4.17	5.43
38th " (Chatham), . . .	20	68.4	4.84	3.45	22.92	30.74	0.87	2.603	12.832	15.435	4.92	6.35
38th " (S. Kensington), . . .	9	63.0	4.16	2.72	20.99	27.46	1.25	2.238	11.413	13.651	5.09	6.60
39th " . . .	68	71.2	5.27	2.63	23.19	29.55	0.96	2.833	12.321	15.156	4.34	5.57
40th " . . .	75	62.2	5.34	2.89	22.56	29.58	0.84	2.872	12.241	15.113	4.26	5.54
MEAN OF ALL RETURNS, . . .	495	66.97	5.08	2.91	22.22	29.38	0.93	2.730	12.113	14.844	4.45	5.62

There are several points of interest shown by these reductions. The working soldier finds it necessary to take about five oz. of flesh-formers daily. The only notable exception is in the case of a detachment of the 38th Company, stationed at the South Kensington Museum. This exception furnishes a ready explanation, for although these soldiers are even better paid than those at Chatham, their work is of a less laborious character, being chiefly that of draughtsmen, photographers, etc.; with this work they do not require a larger quantity of flesh-formers than is consumed by soldiers of the line, and accordingly we find that their diet sinks to this level.¹ Omitting this exceptional case, we find a singular uniformity in the starch equivalent of heat-givers. It is higher than that of soldiers engaged in war, but this is doubtless due to the ease with which potatoes are obtained in garrison, and to their being always in considerable quantity in the diet.

11. We do not possess many well-recorded instances of labourers' diets, by actual weight and measure. The approximative returns obtained by Dr. E. Smith, in his report to the Privy Council on the diet of the working classes, are valuable for what they profess to be, as giving us an insight into the mode of living of artisans; but they can scarcely be considered as presenting us with data of weight and measure, ascertained with any further degree of precision than could be obtained by conversation with working people. I append a few instances of working dietaries, which have been determined by actual weights of the food consumed:—

¹ For this return I am indebted to Captain Donnelly, R.E., Inspector of Science to the Department of Science and Art.

TABLE V.—EXAMPLES OF LABOURERS' DIETARIES.

Class of Labourer.	Flesh-formers.	Fat.	Starch, Sugar, etc.	Starch Equivalent.	Carbon.
English sailor (fresh meat), ¹	5.00	2.57	14.39	20.40	11.05
French sailor, ²	5.74	1.32	23.60	26.70	14.58
English navy (Crimea), ³	5.73	3.27	13.21	21.06	11.46
" " (Ronen Railway), ⁴	6.84	3.82	27.81	37.08	18.96
Hard-worked weavers, ⁵	5.33	1.53	21.89	25.42	13.76
Fully fed tailors, ⁶	4.63	1.37	18.47	21.64	11.74
Blacksmiths, ⁷	6.20	2.50	23.50	29.50	15.69
MEAN WORKING DIET,	5.64	2.34	20.41	25.97	13.89

I have not quoted in this table the well-known allowances of 910 lbs. oatmeal given annually to our Scotch agricultural labourers on the bothy system, and 60 oz. of milk daily. This diet equals $8\frac{1}{4}$ oz. of flesh-formers, 4.5 oz. of fat, and nearly 27½ oz. starch. I attach little importance to this, because it is well known that the labourer sells nearly a quarter of the oatmeal to buy spirits and other luxuries. A man training for prize-fighting,⁸ and who walked seventeen miles daily for exercise, was found to eat weekly 269 oz. of mutton, without bones, 14 oz. of bread (only 2 oz. daily at dinner), and 170 oz. of ale. The food of this prize-fighter had therefore the following dietetic value:—

¹ Advantages of Entering British Navy. Bradbury and Evans, 1854.
² Payen, Substances Alimentaires, p. 322.
³ Dietary to Navvies Employed in making the Railroad in the Crimea (Lethby), Soc. Arts Journ. 1863.
⁴ Gasparin, Cours d'Agriculture.
⁵ Dr. E. Smith, Phil. Trans., vol. 151, p. 747, et seq.
⁶ *Idea*.
⁷ Food consumed by a blacksmith; mean of two days.
⁸ Percy on Fæces.

Flesh-formers,	9.8 oz.
Fat,	3.1 "
Starch,	3.27 "
Starch equivalent,	10.70 "

This result, however, is certainly not an average case, although interesting as showing the conditions employed in training a man to the extreme of muscular activity.

12. From the preceding data we propose to take the following general averages in our calculations:—

	Subsistence Diet.	Diet in Quietude.	Diet of Adult in Full Health.	Diet of Active Labourers.	Diet of Hard-worked Labourers.
	oz.	oz.	oz.	oz.	oz.
Flesh-formers,	2.0	2.5	4.2	5.5	6.5
Fat,	0.5	1.0	1.8	2.5	2.5
Starch,	12.0	12.0	18.7	20.0	20.0
Starch equivt.,	13.2	14.4	22.0	26.0	26.0
Carbon,	6.7	7.4	11.9	13.7	14.3

DIVISION II.

Application of the Preceding Data to Elicit the Source of Useful Work.

13. The common experience of mankind teaches us, that when work is to be obtained from an animal, it must be supplied, in proportion to the labour, with food rich in flesh-formers. Thus a horse, when at work, must be fed with oats or beans, both rich in flesh-formers; a

supply of potatoes or turnips, both abounding in heat-givers, would not enable it to do its work. Professor Dick, the head of the Veterinary College in Edinburgh, tells me that a horse may be kept without work, but taking a little exercise, in fair condition, on 12 lbs. of hay and 5 lbs. of oats; but if a good amount of work is to be got out of it, the horse should get 14 lbs. hay, 12 lbs. oats, and 2 lbs. beans. These diets reduced, as regards their flesh-formers, are as follows:—

Horse at rest,	29·2 oz. of flesh-formers.
Horse at work,	56·2 " " "
Diff. for work,	27·0 " " "

The labour of a horse is generally taken as equal to that of between seven and eight men; and as the working food of a labourer is $5·5 - 2·0 = 3·5$, the proportion

$$3·5 : 27 : : 1 : x,$$

in which $x = 7·7$ leads to the same result. Again, if we compare the labour and food of a horse and of a man when doing the same kind of work, that is, pulling weights horizontally, we have the following ratios, which, from the different character of their food and assimilative processes, must be made upon the flesh-formers actually expended on work external to their body:—

Work of horse, Morin, ¹	12,400,000
Work of man, Rankin, ²	1,500,000 = 8.
Labour flesh-formers in the food of horse,	27
" " " food of man,	3·5 = 7·7.

These ratios are as near as we can expect with animals of such a different character. If we take again two labouring animals of the same herbivorous nature,—the ox and horse,—we can compare their labour and

¹ Morin, *Mech. trans.* by Burnett, p. 397.
² *Ency. Brit.*, Article "Mechanics."

food without complicating the question by deducting the quantity required for *opus vitale*. Experience shows that an ox is well fed on 50 lbs. mangold-wurzel, 3 lbs. beans, and 17 lbs. wheaten straw, the flesh-formers in this food being 38·6 oz. Muschek¹ has given us the labour of an ox, from which we obtain the following ratios:—

Work of horse in foot-pounds,	12,400,000
Work of ox " "	8,640,000 = 1·43.
Plastic food of horse, 56·5	
" food of ox, 38·6	= 1·46.

14. These numbers, so far as they go, appear to indicate that the external dynamical work of animals is proportional to their plastic food. But this is only the common experience of man. The miners in Chili, who work like horses, also feed like them, for Darwin tells us that their common food consists of bread, beans, and roasted grain. During our harvests in Scotland, the reapers consume about 8 oz. of plastic nutriment daily (Christison). Our railway contractors know this necessity of the system so well that they are accustomed to discharge labourers when their appetites fail (Lanckester). And, generally, the previous diet-tables prove this amply, by showing a constant increase of 30 per cent. of flesh-formers in a labouring diet over one fitted for health without hard work, as contrasted with a varying increase of from 5 to 20 per cent. in the heat-givers.

15. Having thus rendered it probable that we are to look to the plastic ingredients of food as exponents of dynamical action, both internal and external to the body of a man, let us now examine the transformations which they suffer. All chemists are agreed that the final

¹ As quoted in Ranken's *Mechanics*.

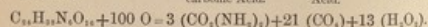
transformation of plastic matter in the body yields carbonic acid, water, urea, and sulphuric acid. Those who believe that the transformation takes place in the blood, agree on this point with those who consider that it is effected in the tissues.

If we therefore take the simplest possible *empirical* formula for albumen, or of tissue formed by it, one representing analysis merely, and not constitution, our views may be more easily understood. Such a formula is $C_{25}H_{33}N_5O_{16}$, in which the 1·2 per cent. of sulphur is for the present supposed to play the part of oxygen.

		Calculated.	Mean of Analyses.
24 C,	288	53·55	53·8
38 H,	38	7·06	7·0
6 N,	84	15·61	15·7
16 O,	128	23·78	{ S 1·2 O 22·3
	538	100·00	100·0

256 666 30·4%
P.C. 10%
clad 23
The transformation of this generic tissue-forming body, still omitting the sulphur, would be as follows:—

Albumen.	Urea or Amido-carbonic Acid.	Carbonic Acid.	Water.
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The simplicity of the transformation is remarkable. Water and two forms of carbonic acid are alone produced; of the latter amido-carbonic or urea is secreted with water *per vesicam*, and the gaseous carbonic acid, accompanied by water vapour, passes away *per halitem* or *per cutem*. If this empirical formula be a fair representation of analysis, and it claims to be nothing more, then, as the result of the transformation, *seven* times as much carbon should escape by the lungs and skin as by

the urine. We can only test this when animals are fed on a flesh diet free from fat. Luckily there are two classes of experiments of this kind, one of them being by Bischof and Voit,¹ and the other by Pettenkoffer and Voit.² The results of the former, omitting the starving experiments on the dog, are as follows:—

	Grammes of Flesh.	C in Urine.	C in CO ₂ .
First Series, . .	1800	Grammes, 24·2	Grammes, 180·8
Second " . .	1500	21·6	162·1
Third " . .	1200	17·7	132·6
Fourth " . .	1800	24·9	186·5
Fifth " . .	1800	25·6	223·3
Sixth " . .	2000	30·3	228·5
MEAN, . . .	1383	24·0	185·6

Before using these figures, we must correct them, for the one per cent. of fat which, according to these authors, still remained in the flesh. If we suppose the fat to contain 77 per cent. of carbon, then 13·83 grammes of fat, in the average daily supply of 1383 grammes of flesh, would contain 10·6 grammes of carbon. Hence we have in reality 175 grammes of the carbon in the carbonic acid due to the flesh alone. From this we obtain the ratio—

$$24 : 175 :: 1 : x \dots \dots x = 7·29.$$

In Pettenkoffer and Voit's experiments, conducted in a like way, but where no correction requires to be made for fat, 21·6 grammes of carbon were found in the urea,

¹ Die Gesetze der Ernährung der Fleischfresser, S. 61, *et seq.*
² Ann. der Ch. und Phar. Suppl. Bd., 1863.

and 148 grammes in the carbonic acid, and small quantity of carburetted hydrogen, which escaped by the lungs and skin. Hence we have—

$$21.6 : 148 :: 1 : x \dots \dots x = 6.85.$$

The mean of these two independent series of experiments shows that 7.07 times as much carbon passes away in the form of carbonic acid as we find in urea, our equation having required 7.0.

16. Having established the fairness of the equation of transformation, we have to ascertain its calorific value. Although we are well aware, as has been shown by Berthelot¹ and others, that this depends for absolute truth on a thorough knowledge of the rational constitution of a body, this need not prevent, until the progress of knowledge teaches us this, our use of approximative numbers: These we can obtain by the following scheme:—

21 C	become	21 CO ₂ ,	Carbonic acid.
3 C	"	3 CO,	Carbonic oxide.
26—16 H	"	5 H ₂ O,	Water.

In this scheme the hydrogen is reduced to ten atoms, because there are already sixteen atoms of oxygen in the tissue, which may be supposed to have united with that element without increase of temperature. The calorific units employed are those of Andrews, viz., 7,900 for carbon, 33,808 for hydrogen, and 2,307 for the 12 per cent. of sulphur in albumen. We do not know experimentally how much heat is given out when carbon unites with oxygen to produce carbonic oxide, but as we do know how much the latter gives out on becoming carbonic acid, it is easy to calculate how much heat a

¹ Acad. de Science, January 1865.

gramme of carbon would evolve on becoming carbonic oxide. The unit of heat by this calculation would be 2227.7. It will now be convenient to ascertain by these numbers how much heat would be given out by the transformation of one ounce or 437.5 grains¹ (28.35 grammes) of tissue. A little calculation shows that this quantity would yield as much heat as would raise 126.5 kilogrammes of water 1° C. This, converted into its mechanical equivalent, gives:—

$$126.5 \times 425 = 53,762 \text{ metre kilogrammes.}$$

17. These numbers can easily be applied. Thus we have seen that a labourer receives 5.5 oz. (155.92 grammes) of flesh-formers in his food. The potential energy represented by this quantity is 295,691 metre kilos.; while the man's labour of raising his own weight one mile high per day is 109,496 metre kilos. But we have not yet deducted the amount of energy required for *opus vitale*, in which we include internal, dynamical, mental, and assimilative work. Concurring estimates

¹ The details of this calculation are as follows:—

One ounce of albumen contains—	
Carbon,	235.37 grains.
Hydrogen,	30.62 "
Nitrogen,	68.68 "
Sulphur,	5.25 "
Oxygen,	97.56 "
	437.48

This, treated according to the equation given:—

C.	201.75 × 7,900 = 1,593,825
H.	33.62 × 2,227.7 = 74,895
S.	8.05 × 33,808 = 272,154
	5.25 × 2,307 = 12,111

1,952,985

1 kil. = 15,432 grs. To convert this into mechanical force:—

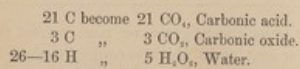
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and 148 grammes in the carbonic acid, and small quantity of carburetted hydrogen, which escaped by the lungs and skin. Hence we have—

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Oxygen,	97.56 "
	437.48

This, treated according to the equation given:—

C.	201.75 × 7,900 =	1,593,825
H.	33.62 × 33,808 =	74,895
S.	8.05 × 2,307 =	18,574
		1,687,294

1,687,294
1 kil. = 15,432 grs. = 126.5 kilogramme units. To convert this into mechanical force:—

$$126.5 \times 425 = 53,762 \text{ metre kilos.}$$

357.57
7.7.

of the force exerted by the heart have been made by Helmholtz¹ and Haughton.² The latter estimates it at 122 foot-tons, or 273,280 foot-pounds, which is more than one-third of the useful work done out of the body. Now, although the motion of the blood in the human body depends almost entirely upon the heart, there are at least indications in man, and clear evidences in plants,³ and in the lower animals, that there are other movements in the system without any *vis a tergo* from an impelling body. If the heart do not use the energy placed at its disposal more economically than the conscious man does the amount with which he works, then it would require nearly one ounce, or exactly 1.20 oz. (theoretically, 0.702 oz. should suffice) of the plastic food. This is very nearly one-half of that which is required for subsistence. The two ounces of flesh-formers used in subsistence would yield by their transformation 253 units of heat, or a mechanical equivalent of 107,524 metre kilos., while the work of the heart is only 37,781 metre kilos. But in addition to the other dynamical work within the body, there is also included in this subsistence quantity both a limited amount of mental work and a full proportional of assimilative work. In the dynamical work, besides the cardiac movements, there are those of the respiratory apparatus, of the diaphragm, of the intestines, and of the arteries. All these in the aggregate represent a considerable, though numerically unknown, demand upon plastic food. And finally, we have the mental work, not considerable certainly in a man fed upon a minimum diet, but probably requiring a certain

¹ Lectures at Royal Institution, Lect. vi.

² New Theory of Muscular Action, p. 23.

³ Carpenter's Physiology, p. 215.

amount for the manifestations of mind to the material world. We cannot therefore be surprised to find that double the amount of energy necessary for the cardiac movements is supplied for the whole functions included in *opus vitale*.

18. The *opus mechanicum* or external dynamical work done by the body of a hard-worked labourer, is to be sought in the 3.5 ounces (99.2 grammes) of flesh-formers which remain after deducting the amount required for *opus vitale* from the total plastic food. But of this quantity one-twelfth appears in the alvine evacuation, without being formed into tissue, and the remainder yields 405 units of heat, or its mechanical equivalent of 172,125 metre kilos.; while the actual amount of useful work performed by the man is 109,496 metre kilos.

19. When we contrast the useful work of a steam-engine with the potential energy supplied to it, this economy of force on the part of the man must appear surprising. But even in the rough mode of calculation available to Scoresby and Joule, to Dumas and Helmholtz, before our knowledge of dietetics had enabled us to consider this question in a more precise way, the relative economy of the human machine excited their surprise. And yet our demand for economy is much greater than they supposed to be necessary, for we require that more than half of the potential energy should be converted into useful work.¹ It may be therefore necessary to adduce general arguments in support of the view that the dynamical action of the body depends wholly on the transformation of the tissues.

¹ It would take from 1000 to 1200 grammes of coal burned in a steam-engine to raise a man from the level of the sea to the top of Mont Blanc; but the same man could do this work in two days by the transformation of 198.4 grammes of dry muscle.

20. Nothing is better established in physiology than that muscular activity is dependent on a free supply of arterial blood to the muscles. When a ligature is applied to a large arterial trunk, the action of the voluntary muscles depending on that vessel is either wholly or partially arrested, at least until the collateral circulation is developed. Thus when the abdominal aorta is tied in animals, their hind legs can scarcely be dragged along (Segalus).¹ Such experiments only prove that a free supply of arterial blood to the muscle, to promote its transformation and to restore its waste, is necessary for the production of muscular action. Anything that interferes with the oxidising influence of the blood upon the substance of the muscle affects the power of movement. In the cerulean disease, when venous and arterial blood become mixed, the patient shows both indisposition and inability for muscular exertion. Like difficulty is observed in the thin air of mountain tops, until the lungs become suited to it. Certain substances which retard the oxidation of phosphorus or phosphuretted hydrogen, even in the presence of oxygen (Graham), such as ether and chloroform, seem to act in a like way on the tissues of an animal, by arresting muscular effort. The proof that there is diminished oxidation in such cases is found in the presence of sugar in the urine. The wayward gait of the drunkard under the influence of alcohol is probably the result of a similar obstacle to change.

Gustav von Liebig² has demonstrated that the oxidation of tissue is quite essential to muscular irritability, which ceases when the access of oxygen is prevented.

¹ Journ. de Phys., 1824.

² Inaugural Abhandl. Giessen, 1853.

and is again manifested when it is supplied. Sczelkow's¹ experiments on the gases of the blood are particularly interesting in this point of view. Arterial blood contains 17 vols. of oxygen and is reduced to 8 vols. in coursing through a muscle at rest, and to between 1 and 2 vols. when the same muscle is in action, the volume of carbonic acid augmenting from 24 to 34½ at the same time. These experiments prove clearly that oxidation and contemporaneous production of carbonic acid attend the transformation of tissues, a fact which other physiologists had shown with less numerical precision formerly. Thus Matteucci,² in confirming the fact that muscular contraction is dependent on the presence of oxygen, showed that the evolution of carbonic acid is proportional to the amount of contraction, a result which has been confirmed by Valentin.³ We need scarcely adduce proofs that the oxidation and production of carbonic acid proceed simultaneously in the substance of the tissue and not in the blood, for as long as the muscle is contractile, after it has been cut off from the blood, the same changes go on. Again, in insects which have no true blood, carbonic acid is produced by muscular activity (Newport).⁴ Valentin⁵ observed that when muscular contraction takes place a greater volume of oxygen is absorbed than of carbonic acid evolved, a result to be expected when we know that hydrogen is oxidised and urea is formed. Helmholtz attempted to follow the changes in a contracting muscle, and found evidence of increasing lactates, but could find no diminution in the fat contained in it, a fact of great significance, as we shall

¹ Sitz. Wiener Acad. 1862.

² Comptes Rendus, xlii. 648.

³ Muller's Archiv, 1845, 8. 72.

⁴ Phil. Trans. 1836.

⁵ Archiv. fur Heilkunde, xiv. 431.

see hereafter. Brown Sequard,¹ by producing a circulation of arterial blood in the body of an animal which had assumed cadaveric rigidity, showed that muscular relaxation and contractility was restored and preserved for a long time, the blood issuing as venous; and he further proved that the elongated condition of muscles required the presence of oxidised blood. I have made experiments along with Mr. Turner, the Demonstrator of Anatomy in the University of Edinburgh, to ascertain whether oxygenated water (peroxide of hydrogen), or a solution of permanganate of potash, would cause relaxation in the muscles of rabbits after *rigor mortis* had set in, as Richardson found. In four rabbits these supplies of oxygen had no effect whatever, either in preventing the access of *rigor mortis* or in relaxing it. I believe therefore that this relaxation is not due merely to the oxidation of the muscle, but to its nutrition by the arterial blood, which feeds it while it removes the effete matter. It will be obvious from the tenor of my remarks, although I am unwilling to complicate the present question by a theory, that I agree with Draper² and others, in considering the contraction of a muscle due to a disintegration of its particles, and its relaxation to their restoration, agreeing also with Dr. Radcliffe³ as to the active state of the relaxed muscle and the exhausted state of the contracted, without assenting, however, to his torpedo discharges as the causes of these states.

21. All these facts prove that transformation of the muscle through the agency of oxygen is the condition of muscular action. Most likely intermediate products are

¹ Gazette Médicale, 1851, and Croonian Lecture, R. S., 1861; compare also Stannius, Virchow's Archiv, 1852.

² Human Physiology, p. 446.

³ Lectures on Epilepsy, 129.

formed before the final forms of carbonic acid and urea are reached. If these graduated changes take place in the muscle itself, the same amount of potential energy will be available as would be if the simplest forms of oxidation were reached at a bound. If lactic acid be the intermediate product of oxidation before carbonic acid, its passage into the latter must be very rapid, for that is continually eliminated from a muscle during its action. And if we thus constantly find that carbonic acid, the highest oxidised form of carbon, is manifested in the substance of muscle during its activity, it is certainly to be expected, that the less oxidised form of amido-carbonic acid should be simultaneously produced. In those cases of disease where elimination of urea is retarded, it is found abundantly in the muscles. Thus, in cholera, especially in the muscles which have been severely cramped, urea is detected with ease. In this disease there is a small amount of chloride of sodium in the blood, and its solvent action on the urea is thus reduced. In uræmia, also, it can readily be extracted from muscular substance.¹ Although in the muscles of certain kinds of fish, as in the *Plageostomata* (Frierichs and Städeler), urea may be always found, yet Liebig² searched for it in vain in the muscles of healthy mammals. Yet this is not surprising, when we consider how long search was made for urea in the blood without success. Although the blood contains the sum of the urea of all the transformations proceeding throughout the body, yet as Marchand³ has shown, the quantity of it which can exist in the blood at any one time is so small that it may readily

¹ Buhl und Voit, Zeitsch. für rat. Med. vi. 94; and Von Bibra, Ann. der Ch. und Phar. xciv. 206-215.

² Chemistry of Food, p. 142.

³ Pogg. Ann. xxxi. 303.

escape detection. If this be true in regard to blood, it is *a fortiori* true in respect to flesh from which the blood is rapidly removing waste matter in the process of the reparation of the exhausted muscle. It may be possible that creatin¹ is intermediate between tissue and urea, but this is a pure speculation; for although we are acquainted with processes by which it can be split into sarkosin and urea, we know of no simple oxidation which will effect this change. Let us inquire how much urea we may expect to find in flesh in a given time, and it will not appear wonderful that it has escaped detection even in the skilled hands of Liebig. In an adult man, 520 grains of urea are secreted in twenty-four hours; hence in one hour $\frac{520}{24} = 22$ grains. Now, although we know that blood is incessantly and promptly removing waste material from the muscles, let us suppose that a quarter of an hour elapses without any of it being taken up, and that the man is killed at this period. Distributed through all the muscles of his body there would be about 5 grains of urea; and in 10 pounds' weight of fresh flesh, the quantity operated upon by Liebig, there could not be more than 0.4 grain of urea, or 0.026 gramme. In this estimation we take the weight of fresh flesh at 1800 ounces. In our present state of analysis for urea this small quantity could not be detected.

22. In considering the origin of energy in the muscles, one of three sources is alone conceivable—(1.) The energy might arise in the circulating fluid itself; or, (2.) The oxygen of the blood might consume the fat deposited in the muscle; or (3.) The substance of the muscle must be transformed to provide the energy.²

¹ Schottin Archiv. für Heilkunde, 1860, 417.

² We do not consider it necessary in the present state of science to present a fourth alternative of the origin of the energy from "nervous force."

We have already (§ 20) shown that the changes which take place in muscle during contraction occur in its substance, and not in the circulating fluid of the capillaries, for irritability continues for a considerable time after the blood has been cut off; and we might here recall the well-known fact, that in spite of a larger quantity of oxygen being taken into the lungs than of carbonic acid evolved, and consequently a necessary evolution of latent heat, the blood of the left side of the heart is 0.2 degrees cooler than that of the right side, showing that oxidation of material is not largely effected during aëration of the blood. We may therefore proceed to the second possible source of energy—the combustion of the fat in the substance of muscle.

23. The usual function of fat is unquestionably, like that of starch or of sugar, to keep up the heat of the animal. When they have served this purpose their physiological work is completed, and the *opus calorificum* cannot be changed into *opus mechanicum*, for that must be due to converted heat, or to force, which has never assumed that form. We know that all the fat

Some old experiments of Matteucci are still, however, constantly quoted in support of this view. He says (Phys. Phen. of Living Beings, p. 325) that the chemical action of three milligrammes of zinc, oxidating and converted into nervous force, in a frog, produced a muscular power equal to 5.419 metre kilos. But the current emanating from the zinc could only have exercised a directive action on the muscle which it affected. The total energy derivable from the zinc can be found as follows:—

$$\left(\frac{0.03 \times 1361}{1000} \right) \times 420 = 1.64 \text{ metre kilos.}$$

Deducting this from 5.42, actually got in the experiment, 3.78 metre kilos. of work must have been obtained from some other source of energy beyond the zinc. There is no other source than the substance of the muscle itself. So long as a muscle is alive and in contact with oxygen it can contract under electrical excitement, and the difference between the work which could be done by the exciting force and the useful work obtained, must be the measure of the energy rendered available by the structural and molecular change of the muscle itself. In a later memoir (Phil. Trans. 1857), Matteucci compares the exciting current to the spark which ignites gunpowder, and would seem to have abandoned his former ideas.

and starch in food is required to account for the animal heat, because it has always been a difficulty to reconcile the experimental heat actually generated by an animal with the amount available in the food-fuel supplied to it. In fact, until the researches of Andrews, and of Favre and Silberman, gave to us higher calorific values for hydrogen and carbon than formerly, there was no possibility of accounting for the heat actually given out by animals in the experiments of Dulong.¹ And even with these increased co-efficients, we require the combustion of all the non-nitrogenous constituents of food to enable us to account for animal heat. But although this is the case, we must bear in mind that only a small quantity of converted heat is theoretically necessary for mechanical work. The energy available in 22 oz. of a starch equivalent of fuel, consumed by a healthy man, would correspond to 2187 kil. units of heat; while the transformation of the muscles of that man, required for mechanical force, yields about 543 kil. units. Although nearly one-half of the latter is spent in internal dynamical work, and passes into heat within the body, still we cannot afford to subtract any of the available work from the heat-givers. Taking it in round numbers, we have 2500 kil. units of heat available from them and converted vital work, and 2700 kil. units are required, according to the estimate of Helmholtz, to account for evaporation, heating of the ingesta, and radiation. The diversion therefore of the ordinary ingredients of food, whose proper function is *opus calorificum*, to the production of *opus mechanicum*, is not probable from *a priori* considerations. But it is nevertheless a fact that fat is

¹ Berl. Med. Ency., Art. "Thierische Wärme;" compare also Fick, Med. Physik. 8. 176, *et seq.*

always present in healthy muscle, and it is desirable to consider its relation to muscular action.

24. The experiments made by Bidder and Schmidt¹ on starving cats, and by Bischof and Voit on a starving dog,² throw light on this subject. From these we learn that during the whole course of starvation, fat disappears from the muscle in a regular manner, while there is no such regularity as to the waste of the tissues. The amount of urea falls to one-half in two days; then remains constant for a week, falling again rapidly and considerably two days previous to death; during all this time the daily waste of fat remains nearly constant. Nor is there anything surprising in this difference. As the animal becomes weaker, the internal dynamical or vital motions decrease, and their representative in the urine naturally falls. But the fat continues to burn in the living lamp, as steadily as the lungs afford to it oxygen.

When Bischof and Voit supplied their starving dog with fat, the waste of the body, as evidenced by the lessened amount of urea secreted, was diminished, because the fat supported the respiration, which before had partially to depend on wasting tissues. The fat cast over them a protective influence, and limited their waste to the support of their own dynamic functions. And in this fact would seem to be the use of fat after it is stored up in the muscle. We allude to its chemical use; for its mechanical advantage in lessening friction, and its possible histogenetic employment in the formation of cells, are not under consideration. Fat does not form a portion of an organ, for ether can ex-

¹ Das Stoffwechsel, 1852.

² Die Gesetze der Ernährung, etc., p. 97, *et seq.*

tract it without any lesion of the organic structure. In wild animals the muscular fat is present in only small proportion—not exceeding two per cent. of the muscle. In the muscle of an active man, the fat amounts to 2.2 per cent. A man in ordinary health and activity wastes daily 1750 grains of dry flesh, or 7000 grains of fresh muscle, which would contain 150 grains of fat. The total amount of heat, which this quantity could yield by its combustion, is 87 kil. units, while the flesh in which it resides would give by its transformation about 506 kil. units. We need not therefore look for the source of potential energy in a minor when we have a major source quite sufficient to account for it. The human heart weighs on an average 9.4 oz., and contains, according to Böttcher, a mean of 1.7 per cent. of fat. On the extravagant supposition, in § 18, that it destroys more than half its substance daily in movements, it would use 147.7 grammes, containing 2.5 grammes of fat. This quantity could by its combustion give 23.9 kil. units of heat, or 10,157 metre kil. of mechanical force. But we have shown that the useful work of the heart is 37,780 metre kils. So that the fat cannot account for the work performed. In these calculations we refer to fat distributed in and inherent to healthy muscle, and not to masses of fat in adipose tissue, such as we find in fattened animals or obese men, for no one pretends that such separate fat can be the cause of movement in any other sense than that starch, sugar, or other body extraneous to the muscle, may, by some unknown or inconceivable method, have this force transformed from *opus calorificum* to *opus mechanicum*. The chemical use of fat deposited within the muscle may be to protect it from the assaults

of oxygen during its repose. A muscle, even at rest, gives out carbonic acid; which is no doubt partly due to the oxidation of its effete particles, but also to the oxidation of fat. The conception that the latter is the source of muscular action can only have arisen from the false analogy of the animal body to a steam-engine. But incessant transformation of the acting parts of the animal machine forms the condition for its action, while in the case of the steam-engine, it is transformation of fuel external to the machine which causes it to move.

25. From the considerations which have preceded, we consider Liebig amply justified in viewing the non-nitrogenous portions of food as mere heat-givers. They never can act vicariously for albuminous bodies as tissue-formers, although tissues may and do evolve heat by transformation when required to do so. That heat-givers do operate indirectly on the waste of tissues cannot be questioned. They facilitate transformation, by keeping up animal heat and by the promotion of circulation. Cold-blooded reptiles become more active when artificial warmth is supplied to them, and conversely, warm-blooded mammals become more sluggish when the heat of their bodies falls, as during hibernation. Such dependencies of different groups of food, acting co-ordinately, are incessantly found, but nevertheless each group has its own specific work to perform.

26. While we have been led to the conclusion that the transformation of the tissues is the source of dynamical power in the animal, we have yet to examine whether the occurrence of heat, and electro-motive force current in the muscles, may not be evolved from and thus absorb the force on which we have relied. The muscle during

contraction is certainly hotter than at rest, about 0.5°C . warmer, according to Becquerel and Brechet. In fever, the temperature of the muscles rises sometimes to 40° or 41°C ., and in tetanus to 44°C . (Ludwig); while Fick has shown that in these cases the muscles are hotter than the circulating blood. But the experiments have been made when the waste of tissue is not producing useful work, and must therefore necessarily pass into heat. Beclard¹ found in fact that the heat developed in a muscle is in inverse ratio to the mechanical effects produced; for example, in trying to raise insuperable weights, more heat is evolved than in lifting lighter weights. Hirn² also ascertained, by direct experiment on a tread-mill, that less heat is evolved for each gramme of oxygen taken into the body when hard work is done outside the body. In fact, the heat developed in muscles, when not due to the combustion of fat, is probably only the result of lost work, just as we find that the electromotive force disappears almost entirely during the active work of a muscle or nerve³ (Du Bois Raymond). Even with the wonderful economy of force which the animal as a machine exhibits, we cannot be surprised that some of the lost work is manifested in the forms of heat and electricity. We know, for instance, that all the potential energy rendered available for internal dynamical work must assume ultimately these forms.

¹ Comptes Rendus, 1860, I. 471.

² Théorie Mécanique de la Chaleur, I. 34.

³ Untersuchungen über Thierische Electricität, Bd. II., 511.

DIVISION III.

*Secretions as Measures of Work.**A. Secretion per vesicam.*

27. We have now to examine how far the secretions present us with measures of the work performed by the body. Commencing as we did in the first division of the lecture, it is necessary to inquire how far the urea secreted by a man living on a mere subsistence diet, represents the amount of tissue which we have supposed to be wasted in internal dynamical work. Further on it will be seen that, in a man of good digestion at least, one-twelfth of the nitrogen of the food passes away in the fæces, without having been built into muscle or other tissue. Hence, of the 875 grains (2 oz.) of flesh-formers required to support *opus vitale*, 73 grains will pass out *per anum*, and 802 grains will be moulded into tissue, and be transformed into urea and the other products of wasted muscle. Hence, in the urine of a man supported by the lowest diet sufficient for life, we should still find 267 grains of urea. The same amount must appear in the first days of starvation, during which life is supported by the wasting tissues; or what is the same thing, it will appear when non-nitrogenous food is taken. In Ranke's experiments upon himself, we find that, in the first case, he passed 17.02 grammes of urea, and in the second case, 17.10 grammes.¹ The mean gives 263 grains of urea, a number remarkably close to our calculated quantity, and probably identical, if the undetermined uric acid be accounted for. Beigel² during

¹ Müller's Archiv, 1862, S. 358.

² Nov. Acta. Acad. Nat. Curios. xxv.

a three weeks' "hungercur," found the urea sink to 17.83 grammes, or 275 grains. A patient in the fifth week of typhus would possibly pass even less than 267 grains of urea, because part of the subsistence food, in the low state of dynamical vital work, would go to build up tissue; and accordingly we are not surprised to find that Brattler,¹ in the fifth week, found the urea as low as 16 grammes (247 grains). But when the patient becomes convalescent, and receives the standard diet for quietude, viz., 2.5 ounce of flesh-formers, he should then pass 335 grains of urea. Turning to the researches of Vogel² and of S. Moos,³ we find that the secretion gradually rises from 22 grammes (339 grains) to the normal quantity of 35 grammes. Haughton⁴ also states that convalescents in hospitals pass about 300 grains of urea.

28. The experiments of the latter observer on the amount of urea secreted by average healthy men, living on a mixed diet, give from 560 to 580 grains. The mean of the extensive table of analyses in Parkes⁵ excellent work is, however, only 512 grains. If we add to this his average for uric acid, in its equivalent of urea, we would have 521 grains. If now we take as a mean, for the present, the results of Barral,⁶ Valentin,⁷ Vierordt,⁸ and E. Smith,⁹ for the nitrogen in the feces as being about one-eighth that in the urine (one-twelfth, according to Ranke), then this, calculated as urea, would

¹ Ein Beitrag zur Urologie, 1858, p. 19.

² Zeitschr. f. rat. Med. iv. p. 362, et seq.

³ *Ibid.* vii. p. 291.

⁴ Urine of Healthy Men, p. 30.

⁵ Parkes on Urine, p. 15.

⁶ Comptes Rend. xxvii. 361. Ann. de Ch. et Phys. [3], xxv. 129, 171.

⁷ Text-Book of Phys. 326.

⁸ Vierordt, Phys. 192.

⁹ Phil. Trans. v. 151, p. 747, et seq.

give $521 + 65 = 586$ grains of an equivalent of urea. We can convert this into flesh-formers:—

$$586 \times 3 = 1758.$$

Now 4 oz., or 1750 grains, form the usual diet of non-labouring men.

It will thus be seen that numbers closely approximating to the demand are obtained from recognised averages. But in order to apply them to the special class of healthy men (soldiers) described in Table II., we must take the diet as there given. Soldiers during peace are supposed to be well exercised by a daily march of seven miles. This march represents work equal to 38,333 metre kilos. If we take Haughton's mean of 575 grains of urea for such men, then the tissue transformed to produce this would be 3.94 oz., to which, using Ranke's proportion of one-twelfth of nitrogen in feces, as we do for reasons hereafter to be stated, 0.33 oz. have to be added; making 4.27 oz. as against 4.21 oz. in Table I. Taking, then, 3.94 oz., we have:—

Potential energy in transformed tissue,	211,822 metre kilos.
Useful external work,	38,333 „

But as the former number includes the energy required to support *opus vitale*, we obtain the amount available for external dynamical work by subtracting it:—

$$211,822 - 107,524 = 104,298 \text{ metre kilos.}$$

Hence we have still nearly three times as much force available as is represented by useful work; but we need not be surprised at this, when we know that the healthy soldier is capable of more exertion than he takes in peace.

29. Passing from our standard man in health to a hard-worked labourer, we can readily calculate how much urea should be produced by his plastic food. We obtain the amount which is transformed from tissue by deducting that which passes away as feces :—

$$2406 - \frac{2406}{12} = 2205.5 \text{ grains.}$$

Without any error worth taking into account, the urea may be obtained by dividing this number by 3 (the correct number is 3.01); hence the working man, doing really a hard day's labour, should have 735 grains of urea in his urine, including its equivalent of uric acid. There are very few estimates of the urine of hard-worked labourers, and I have found it no easy matter to induce them to be made the subject of experiment. Nevertheless, in conjunction with my friend Dr. A. Dalzell, I have estimated the amount of urea in the urine of hard-worked labourers, and we are still continuing our inquiries on this subject. Before alluding to them, it will be more convenient to consider Dr. E. Smith's¹ researches on weavers and tailors. The two weavers were engaged in "the very laborious occupation of wide-width coccomatting." Applying my tables to the recorded food of these men, I find that they received a daily supply of 5.33 oz., or 2333 grains of plastic nutriment, containing 366 grains of nitrogen. As an average of twenty-six days' experiment they gave :—

702.9 grains of urea, containing . . .	328.0 grs. nitrog.
8.52 oz. feces, containing . . .	40.93 " "
Total nitrogen, . . .	368.93 " "

As this differs by only three grains from the nitrogen of

¹ Phil. Trans., v. 151, p. 747, et seq.

the ingesta, as determined independently of the experiment, the latter has obviously been done with great care.

The tailors, who were fully fed, received 4.63 oz. flesh-formers, according to my tables, containing 318 grains of nitrogen, and as an average of twenty-six days gave in egesta :—

608.4 grains of urea, containing . . .	283.7 grs. nitrog.
6.98 oz. of feces, containing . . .	27.43 " "
Total nitrogen, . . .	311.13 " "

These tailors were however overfed, for while the weavers slightly lost weight, the tailors gained about 16 oz. each during the experiment. The lesser quantity of urea in this case was a necessary result of diminished food and work as compared with the weavers.

A distinguished colleague in my University, Professor Christison, whose knowledge as a chemist does not require to be referred to, had long since the idea that work, with corresponding food, increased the urea. When he was twenty-eight years of age and remarkably vigorous, he worked for two days as a carpenter to try this problem, and in addition walked on each of these two days ten miles, at a pace of nearly five miles per hour. As a mean of the two days, he passed 845 grains of urea, but as the process of analysis was not then by the mercury method, we may reduce it to make it comparable to our present standard, to 800 grains. But perhaps this may be too large a deduction, as we find that Hammond, exercising himself in a similar hard way, passed 865 grains.

We may compare these instances with those recently determined in my laboratory, and which were generally

made on two men in each occupation for at least two days :—

Hammerman,	530 grains.
Quarrymen,	550 "
Tailors,	608 "
Weavers,	703 "
Blacksmiths,	695 "
Forgemen,	740 "
Hard-working—pedestrian,	800 "

The work of the two first set of workmen is fatiguing, but not laborious. The work of a hammerer (9) is 480,000 foot-pounds, which is within the capability of a fairly fed man with 4·2 oz. of plastic food. The difficulty of getting working men to understand the value of such inquiries has considerably retarded these determinations. In the case of the two blacksmiths, the difference between the urea of Sunday and labouring days is instructive :

	Sundays.	Labour Days.
H. { 1. 38·56 grammes.		1. 41·38 grammes.
2. 34·47 "		2. 46·69 "
Mean, 36·51		44·03
M. { 1. 31·42 grammes.		1. 40·61 grammes.
2. 31·06 "		2. 49·08 "
Mean, 31·24		44·84

H. on the Saturday evening previous to the first Sunday had killed a pig and made merry with his friends, having, in fact, been drunk ; hence that day's urine was probably deranged. Taking the mean then of the three observations, we have for

	Grammes.	Grains.
Sundays, or days of rest,	32·32	499
Week-days, or days of labour,	44·43	686

The difference between 686 and 695, as given in the table, is for the equivalent of uric acid.

30. It will be seen that the demand of 730 grains of urea for a man doing the hard work of 790,000 foot-pounds is not beyond what is found in many cases. In fact, it follows as a necessity, if Tables III., IV., and V. are correct returns of the food of men engaged in labour. The researches of Lehmann¹ and Ranke² have shown, that when much nitrogenous food is taken, an increase in the amount of urea follows. If, then, the plastic food of the adult man stands to the hard-worked labourer as 4·2 : 5·5, the urea must increase in nearly like proportion. There is now no longer any question that all the nitrogen of the ingesta is to be found again in the urine and faeces. Bischof and Voit³ have proved this for dogs ; Henneberg⁴ for cows ; Voit⁵ for dogs and pigeons ; Lehmann⁶ for pigs ; Ranke⁷ and Smith⁸ for men. As this is now determined beyond doubt, it scarcely needed new experiments to prove that a labourer, eating more food than a man not working, must pass more urea than the latter. The dispute as to the effects of *luxus consumption* involved the decision of this as the common battle-field for the disputants on both sides. Thus Beigel⁹ found a secretion of 711 grains of urea in the case of men, when they had lived on animal food and rested, and 806 grains, under the same conditions, when they had active work. Becher found 729 grains,

¹ Phys. Chem. ii. p. 450.

² Ranke, Müller's Archiv, 1862.

³ Ernährung des Fleischfressers, 1860.

⁴ Quoted by Voit, *infra*.

⁵ Stickstoff-Kreislauf. Ann. der Ch. und Phar. 1863 ; Supp. Bd. 238.

⁶ Zoochemie.

⁷ Op. cit.

⁸ Phil. Trans. 1862.

⁹ Day's Phys. Chem. p. 43.

Lehmann 798 grains, and Ranke 1330 grains under like conditions. We need not therefore discuss the *questio vexata* as to whether albumen may or may not pass directly into urea, when in excess in the blood, without being built into tissue, for this is not the normal mode of nutrition. *Luxus consumption* may be a question to discuss when considering aldermanic dinners, but it can have no meaning when applied to the hard fare of the artisan, who takes no more food than is necessary for his work. The discussion also as to whether exercise increases the elimination of urea has little further interest for us, when we find such men as Lehmann,¹ Hammond,² Beigil,³ Speck,⁴ Franque,⁵ and Beneke,⁶ deciding in favour of the fact that it is increased, against the varying experiments of Voit⁷ and the younger Draper⁸ on the other side. Dr. E. Smith has explained many of the anomalies of the latter physiologists, by showing that the period of the production of urea is not necessarily its period of elimination.⁹ In most of the experiments made on this subject, the heavy exercise has been taken, not with the corresponding diet, but with the old diet; and under such circumstances, the increased elimination

¹ Phys. Chem. Bd. ii. 449.

² Amer. Jour. Med. Soc. 1855 and 1856.

³ Ueber die Harn, etc. 8. 42.

⁴ Archiv. des Vereins für Wiss. Heilk. Bd. iv. 484, and Bd. vi. 161.

⁵ Schmidt's Jahrbuch, 1856.

⁶ Nord. Soc. Bd. 1855, p. 83.

⁷ Untera, über den Einfluss der Muskelbewegung, etc., 148, et. seq.

⁸ New York Jour. Med. 1856.

⁹ The experiments of E. Smith upon prisoners working on the tread-mill are perhaps the most difficult to explain, for with this heavy work there was only an increase of 16 grains daily. They worked for one-third the time, but clearly under abnormal conditions, for "their muscular system was overworked and underfed." Their food I find contained daily 250 grains of nitrogen, while their urine and feces contained 280 grains. Hence the working experiment was not one of health. The probable explanation lies in Smith's own words: "The reparation is in excess during the periods of rest, and restores the equilibrium on a long average."

of urea from the system is sometimes retarded two days. Hammond's experiments, even upon the same diet, were however very conclusive. His results are as follow:—

	Urea.	Uric Acid.
With no exercise,	487.0 grs.	24.9 grs.
Moderate "	682.1 "	13.7 "
Hard "	865.0 "	8.2 "

31. When a large amount of animal diet is the chief source of food, exercise becomes a necessity, in order to waste the tissues for the support of respiration and other vital movements. Without it the animal soon loathes the food. This is not only the experience of carnivora, but also of man. Darwin tells us that, when in the Pampas, he lived tolerably well on a meat diet, "but felt that it would only agree with me with hard exercise;" and he tells us that the Guachos, who live upon meat, eat largely of fat, probably not only for respiratory food, but also as a protection against unnecessary muscular waste, as we have explained. Sir John Richardson observed the same fact in his Arctic travels, having noticed "that when people have fed a long time solely upon lean animal food, the desire for fat becomes so insatiable that they can consume a large quantity of unmixed, and even only fat, without nausea." The hyena in confinement wastes its tissues by moving backwards and forwards incessantly in its den, and thus is able to consume its animal diet. All this shows that the normal function of nutrition is to build in plastic food into tissues, to be transformed by internal and external dynamical work into carbonic acid, water, and urea.

32. We have confined our attention chiefly to urea, because, as a representative of dynamical labour, it is

not mixed up with any other kind of work, such as *opus calorificum*. Carbonic acid is a marked product of work, but then it represents the sum of two factors,—increase in dynamical and in respiratory action. Thus a labourer, living upon our standard diet, exhales in eighteen hours' quietude, and six hours' hard work, the following quantities of carbon, in the form of carbonic acid, after deducting the carbon in urea and in feces:¹—

In 18 hours' quietude, 2375 grs. of carbon.
6 " labour, 3212 " "

In one hour's work, 535 grains of carbon are exhaled as carbonic acid, of which nearly one-fourth, or 135 grains, is due to the transformation of tissue, and the rest to the increased demand of the oxygen inspired for non-nitrogenous food.

B. Assimilative Work, as Measured by the Secretions per Annum.

33. The measure of the digestive or assimilative work, in a man of healthy digestion, is, I believe, to be found in the nitrogen of the feces.² Although the alvine evacuation frequently does contain undigested food, either in cases of over-eating or of indigestion, in full health it is difficult to find with the microscope even traces of undigested food. Bischof and Voit could not detect any muscular fibres in the feces of their dog; and not even

¹ 220 grains of carbon are allowed for feces, all of which is deducted from the six hours' labour.

² It is only as this lecture passes through the press that I observe Marcet has given the same view, without however working it out. Not having found any such views in his two papers on feces, I did not think of looking at his lecture on the chemistry of digestion till the last moment. The passage to which I refer is as follows:—"The principal object of the alvine evacuation is obviously to rid the body of certain parts of the intestinal secretions, which, after having served their purpose in effecting the digestion of food, are not fit to return to the blood."—*Jour. Ch. Soc.* xv. 418.

fat, when that had been purposely added to the meat. Rawitz³ and other observers are of the same opinion. Hence the common notion that feces represent the refuse of food is not supported by correct observation. Undoubtedly they contain various ingredients, nitrogenous as well as non-nitrogenous, mixed with mineral matter (Marcet).⁴

34. The average weight of feces secreted in health is 4·6 oz., according to Wehsarg,⁵ or 5½ oz. (Liebig). In Ranke's⁶ experiments, on a mixed diet, the nitrogen excreted by the feces is to that in the urine as 1 : 12·5. We take one-twelfth as the amount in health. But although this is the case in man, it is not so with regard to the carnivora. In Pettenkoffer's experiments with a flesh-fed dog, the nitrogen in the feces was to that in the urine as 1 : 72; and in the still more extensive experiments of Bischof and Voit, as 1 : 76. But the ratio⁷ alters when fat or starch is added to the flesh; in the first case it is as 1 : 41, and in the second 1 : 40. When the dog was fed on flesh and sugar, it was as 1 : 23·3, and on starch alone the proportion became reversed, and then the nitrogen in the feces was to that in the urine as 2 : 1. A little consideration will explain these differences. There are four fluids engaged in the promotion of digestion. All of them contain albuminous fer-

³ Ueber die Einfach Nahrung Mittel.

⁴ Phil. Trans. 1854 and 1857.

⁵ Mikros. Und. Chem. Untersuchg. des Feces, 1853.

⁶ Op. Cit. p. 311.

⁷ These numbers are relative, not absolute. The feces of flesh diet contained 6·5, of starch 4·4, of sugar 7·9 per cent. of nitrogen; but the proportions of nitrogen in urine to nitrogen in feces are as given in the text. Thus we find, on summing up the quantities, that the nitrogen in urine and in feces, on a diet of flesh and sugar, is, in grammes, as 85·22 : 3·65; on flesh, starch, and fat as 101·46 : 2·57; and on starch alone as 5·68 : 10·26. I have omitted the feces on bread diet, for they seem to have been chiefly undigested bread.—(*Ernährung des Fleischfressers*.)

ments, which receive special names, as pepsin when in gastric juice, ptyalin when in saliva, pancreatine in pancreatic juice, and intestinal ferment in the juice of the intestines. But we know nothing more of their chemical composition than that they are albuminous bodies, slightly oxygenized, and in the process of change. We do know that they have different actions,—pepsin acting on albuminous bodies, ptyalin and pancreatine converting starch into sugar, and the latter fat into its acids and glycerine; but in all probability the same ferments in different conditions produce their varying effects, just as we find the gastric ferment also able to act upon fats as well as on flesh-formers,¹ and the intestinal ferment combining the functions of the salivary, gastric, and pancreatic ferments. In fact, experiment tells us that alkaline gastric juice acts like pancreatic juice, and the latter, when acidified, plays the part of the former.

Referring to the proportion of nitrogen in the urine to that in the feces of the carnivora, it is now possible to explain the apparent anomaly, that the addition of non-nitrogenous aliments to the diet, increased, instead of diminishing, the amount of that element in the feces. When the animal is fed on flesh free from fat, the gastric ferment alone is brought into activity, aided partially perhaps by the intestinal ferment, and the residue of these appear in the feces, which are found to contain but little nitrogen. When fat is now added to the diet, a large amount of pancreatic juice is brought into activity, and the used-up ferment of this juice is added to that of the gastric and intestinal juices as before. Hence we find that the proportion of nitrogen in the feces is

¹ Marcei, *Chemistry of Digestion*, Chem. Soc. Jour. xv.

increased. When starch is mixed with the flesh, then the salivary ferment co-operates with the other three ferments in preparing the food for assimilation, and we find the proportion of nitrogen rather greater than before. When a carnivorous animal is placed in such an anomalous position as in feeding it on starch alone, a much larger quantity of salivary, pancreatic, and intestinal ferments appear to be called into action to digest this unusual and unmixed diet, and hence the amount of nitrogen in the feces becomes increased to an unusual amount.

35. The usual amount of nitrogen in the feces of man is 6.5 per cent. in dry, and 1.7 in fresh excrement; while the carbon is from 43 to 44 per cent. in the former. This is almost identical with the composition of normal feces in the carnivora. The reason obviously is, that the changed albuminous ferments, which form the nitrogenous constituents of feces in health, are the same in both classes of animals. Just as yeast loses some of its nitrogen by work; as emulsin becomes poorer in nitrogen and richer in oxygen when it has ceased to act on amygdalin, so do these different forms of albumen in their degradation suffer like changes. A well-known experiment of Lehmann is instructive on the subject under consideration. When emulsin (the casein of sweet almonds) is introduced with amygdalin into the stomach of an animal, the well-known fermentation, by which that body is converted into oil of bitter almonds and prussic acid, takes place, and the animal dies. On the other hand, when emulsin alone is introduced to the stomach, and amygdalin is injected to the blood, the animal does not suffer by the experiment. But upon reversing the mode of administration, and injecting the

emulsin to the blood, and putting the amygdalin into the stomach, the animal dies as before. Hence we find that the ferment, after acting upon the substances which it met with in the intestines, could not be absorbed; for had it been, it would have met with amygdalin in the blood, and would have produced fatal effects. That it had acted as a ferment upon the materials in process of digestion, and had become exhausted, is certain, for it altogether changed in its passage, the fæces of the animal not containing any emulsin capable of acting upon fresh portions of amygdalin. No experiment could be more conclusive for our views, because emulsin is simply changed casein, as these digestive ferments are changed albumen, each having certain peculiarities of action, according to the alkaline or acid fluids with which they act, or with other varying conditions.

36. Let us now return to the proportion of nitrogen found in the alvine dejections of man; it stands in relation to that in the urine as 1 : 12. Where it is present in larger proportions than this, then the excess is probably due to undigested flesh, or to an excessive secretion of ferments necessary to overcome some digestive difficulty. In other words, one-twelfth of all the plastic food taken by a man is converted into digestive ferments, and then is excreted *per anum*.

I am not inclined to agree with those physiologists¹ who consider that these ferments secreted from the blood are the degraded products of tissue-waste in their passage to urea. On the contrary, I believe them merely to be albumen of the blood, the oxygenation of which is incipient, so as to make it ready to build up tissue, as in

¹ Draper's Human Physiology, p. 84.

its passage to fibrin.¹ Hence, when there is an extensive demand on the blood for tissue-material, as in the case of work in excess of the food supplied (for instance, as observed by E. Smith with his overworked prisoners), then the amount of the alvine dejection diminishes. These digestive ferments secreted from the blood cannot be albuminous materials in a downward career, otherwise their surplus, beyond that required for fermentation, would not again be absorbed into the nutrient fluid. It is only a small portion of the whole that is rendered unfit for re-absorption and is reduced to a degraded condition. If the great bulk of what is generally esteemed to be the ferments were not taken back into the blood, the amount of nitrogenous matter in the alvine dejections must be much greater than we find to be the case. Let us take very moderate computations as to the quantities of digestive juices secreted in twenty-four hours by a standard man, and this re-absorption will appear to be a necessity—

1.6 kilog. of saliva ²	contains 2.4 grammes ptyaline.
6.4 " gastric juice ³	" 20.5 " pepsin.
4.0 " pancreatic ⁴	" 50.8 " pancreatin.
0.2 " intestinal ⁵	" 1.8 " ferment.
Total, 75.5 grammes.	

Now as the whole fæces contain only 9.4 grammes of these exhausted ferments, it is obvious enough, that the

¹ Smees, R. S. Proc. xii. 399, 505.

² Dalton's Human Phys. p. 96.

³ Katherine Kutt, the Estonian peasant, with a gastric fistula, gave no less than 39 lbs. daily; the usual estimate, however, from researches on dogs, and applying them to man, is 14 lbs.

⁴ The estimates on this subject vary enormously, some going as high as 15 lbs. for a standard man. I have therefore taken a low estimate, nearly that of Bernard, who has devoted so much study to the pancreas.

⁵ I allow this for intestinal juice, from the experiments of Bidder and Schmidt. Probably all the estimates are 25 per cent. too low.

larger quantity represented above cannot consist of degraded matter in its descending career. When it is further borne in mind that the daily waste of tissues in a healthy man is only 112 grammes, it is impossible for us to suppose that more than half that quantity of degraded matter is preserved in the blood, to be excreted and then re-absorbed. This view would be quite inconsistent with the admirable arrangements of the excretory organs for speedily carrying off used-up matter from the nutrient fluid.

The functions of these digestive secretions must be considered as assimilative, in the largest sense of the term. Chemical affinity generally is assimilative effort. When hydrogen unites with oxygen, each element endeavours to assimilate the chemical characters of the other element to itself, and when they are equal in power neutrality results. These ferments, as they are termed, when secreted in the digestive fluids, are albuminous substances changed and fitted for assimilation in the body, and capable of preparing the ingested food to assume their own state. They meet with resistance, which their large mass enables them to overcome, but a small portion of them succumb in the conflict, and are finally excreted in the alvine dejections, along with certain non-nitrogenous materials which have probably been used in co-operation with them to fit the calorific constituents of food for absorption into the blood.

CLIMATE OF THE SWISS ALPS
AND OF
THE PERUVIAN ANDES
COMPARED.

BY
ARCHIBALD SMITH, M.D.

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CLIMATE
OF THE
SWISS ALPS AND OF THE PERUVIAN ANDES
COMPARED.

ON the main points enumerated by Dr. Hermann Weber, in his "Notes on the Climate of the Swiss Alps," in a meteorological, physiological, and pathological aspect, I shall offer a few brief observations in reference to the corresponding influences of elevation on the Peruvian Andes.*

1. Says Dr. Weber:—"The temperature is lower; it decreases in proportion to the increasing elevation at the average rate of 1° centigrade, 1.8° F. for every 545 feet. The annual and monthly variations are less great on elevated places than in plains."

Upon this proposition I have to observe, that the elevation and temperature on the Peruvian Andes do not bear to each other the uniform relation they appear to hold in Switzerland. At Lima, situated little more than 500 feet above the level of the Pacific Ocean, the mean temperature of the atmosphere, which no storm or tempest ever agitates, is approximately, 72° Fahr. throughout the year; its ordinary minimum Winter temperature being about 60°, and its Summer usual maximum being about 84° in the shade.

But if we ascend to the western aspect of the Eastern Cordillera, where, at the silver mines of Cerro-Pasfo, the elevation by barometrical measurement, according to Rivero, is 14,207 feet; and,

* The author may here be allowed to say, that his observations on Dr. Weber's Notes on the Climate of the Swiss Alps, which appeared in this Journal February, 1864, were written and communicated to that gentleman without any view to publication, and it is only at his kind suggestion they are now published.

according to Herndon, 13,802 feet by the boiling point of water, the mean temperature during the dry season, as observed by Rivero, is 44° Fahr. by day, and 35° Fahr. by night; and in the wet season I myself never observed it below 36° Fahr. in-doors. In course of the months July, August, and September, the meteorological variations at Cerro-Pasco are very trifling; and the daily changes are unimportant—the weather being generally dry and sunny by day, and more or less frosty by night. So far, then, the temperature at Lima, as compared with that at Cerro-Pasco, decreases with the increasing elevation, but not in a regular scale of gradation. For example, at the elevation of Surco, about 7,000 feet up the valley of Rimac, the average temperature will be little under that of Lima; and in the inter-Cordillera valley of Huanuco, at about the same elevation—viz., on the Estate of Andaguaylla, the temperature of the atmosphere, as registered by me, in the shade of an open veranda, was, during three consecutive years, regularly ranging between 66° and 72° Fahr. Here, then, we see that the decrease of heat does not proceed uniformly with the vertical elevation, and that the rule of one degree centigrade of decrease in temperature for every 545 feet of ascent above sea level, entirely fails on the Peruvian Andes.

2. "The atmospheric pressure decreases, or the air becomes thinner with the increasing height."

Herndon, in his work entitled *Exploration of the Valley of the Amazon*, states, that on the eastern slope of the Andes, the trade winds are so dammed up by the mountains that the atmosphere is compressed, and consequently heavier than it is farther from the mountains, though at a lower elevation. The fact is worthy of remembrance in connexion with Andine climate, inasmuch as it shows that the Atlantic slope of the Peruvian Andes, thus favoured by the trade winds, is remarkable for humidity of atmosphere, and consequent exuberant vegetation; while the Pacific slope is equally remarkable for its vast extent of arid soil.

3. "The absolute amount of humidity in the air becomes probably less with the increasing elevation, but the relative amount or the degree of saturation, is, in general, greater in the lower mountainous regions."

The law, as here laid down, fails in its general application to the

climate of the Peruvian Andes. From the elevation of 1,500 feet above the Pacific Ocean—to which height the sea vapours seasonally reach (especially in the months of June, July, and August)—to the elevation of about 7,000 on the western slope of the Andes, there is a zone of about 5,000 feet, of absolute aridness, on which rain never falls. Above the rain line, on the Pacific side, at, or about 7,000, to the line of permanent snow at or about 15,000 feet, the intervening region is partly cereal and partly pastoral. In this way, the whole coast and lower Andine hills of Peru, may be said to be rainless, as the drizzle that falls from May to October seldom forms into regular rain-drops. But, during the wet season of the Sierra—or the Alpine range, so called, above 7,000 feet—it rains there uniformly in the afternoon; and on the Cordillera it often snows heavily at night; though on the elevated pasture grounds the snow of night usually melts into floods of water and swollen rivers with the return of the morning's sun.

4. "The rapidity of evaporation is increased in the higher mountainous regions."

For full six months in every year, the irrigation and fertility of the lower valleys and coast of the western side of the Peruvian Andes, with its *quebradas*, or deep glens, depend on the rain and snow that fall on the Cordillera, and the cold, inhospitable pasture lands generally called "puna" in Peru.* From this source it is that the rivers of the coast swell periodically. We may, therefore, infer that rapid evaporation on the Andine heights must be confined to the dry months, when the Cordillera sun is very hot and scorching; and, consequently, not uniform in degree, but dependent on variations of season.

On the sandy coast of North Peru, the province of Piura is so excessively dry and sunny, that the Summer temperature, in the shade, rises there to 90° Fahr.; and, on a computed average, it does not rain more than once in ten years. But in Piura, both the radiation and evaporation must be more rapid along a desert shore-plain than on the cold and wet plains and *puna* regions of Junin and other table lands at the elevation of 13,000 feet, and upwards, above the sea.

* This word is derived from "Pugna," now obsolete, according to the authority of the Dictionary of the Spanish Academy, and which means "regio frigoris, asperitate inhabitabilis."

5 and 6. "The motion in the atmosphere is considerably greater on the mountains than in the plains."

On the coast of Peru, strong atmospheric currents are never observed; and though earthquakes are common, a thunder storm has not been seen in the neighbourhood of Lima during the lifetime of any one now living.

7. "The air of the highest regions of Switzerland is free from marsh-malaria."

At the mines of Cerro-Pasco, I have seen intermittent fevers, though they never originate there, nor on the surrounding heights; they are imported there from either the malarial valleys of the coast, or the deep and sultry inland valleys where malaria prevails. But, wherever contracted in the first instance, "*terciada*" readily recurs in an individual whom it once attacks, at all elevations, indiscriminately, as I can attest from my own personal suffering for a protracted period, on coast and mountains, when labouring under this malady, which I had first been affected with in Lima.

8. "The sky is, in the sub-Alpine regions, more frequently dull by mist and clouds than either in the plains or the higher Alpine regions."

During the wet, or rather the damp and misty season, on the lower maritime plains and valleys of Peru the sky is usually canopied with white flaky clouds; and the lower limit of the arid mountainous zone—which neither rain from the Sierra, nor vapour from the sea-board ever bedew or refresh—is usually in the wet season, on the coast, skirted by a wall of dense mist or fog. But the sky of the dry intermediary valley, where the magnéy and castor oil plant naturally flourish, is generally throughout the whole year remarkably pure, bright, and serene. On the other hand, the sky of the Cordillera range is often shrouded in the dark mantle of the gathering storm, and the thunder rolls in loud peals, and among bursting clouds, from peak to peak in fearful majesty, during the rainy season of the high Alpine regions.

9. "The degree of insolation, or exposure to the rays of the sun, is greater in elevated situations."

On the Peruvian Andes, the highest degree of insolation is

experienced in the dry and hot intermediary *Quebradas*, or mountain chasms, with here and there patches of cultivated land, under the *rain line*, where fever and sun stroke are sometimes its consequences.

For full one-half the year, on the open *puna* and adjacent Cordillera, we have not only monthly, but daily obscurations of the sky, and frequently very rapid transitions of snow, hail, sleet, and rain with morning sunshine: this is the rainy season. In the dry season on the Sierra, however, the sun of the Cordillera is proverbially hot and penetrating, scorching the skin, particularly of the face, when exposed to its burning rays; just as the wind of the Cordillera, during the same season, is peculiarly cutting, desiccative, and irritating to the air passages of the nose and fauces.

10 and 11. "The respiratory movements become increased in frequency and depth, with increasing elevation; and the contractions of the heart become more frequent in proportion to the elevation."

After a quiet residence of a few days at the mines of Cerro-Pasco, the Cornishmen in the service of the Peruvian Mining Company, who were engaged there in 1826, generally got easily over the headache and sickness which attend the *seroche*, or Cordillera sickness; but the breathlessness, hurried action of the heart, and sensation of throbbing and tension at the temples—symptoms which usually accompany a sharp attack of the *seroche*—were always readily induced by active exertion—such as climbing a steep shaft in a hurry, or attempting to run, and even to walk fast on the open plain. In its more severe and fatal examples, the *seroche* is attended with formidable hemorrhages, such as nasorrhagia, gastrorrhagia, and pneumorrhagia, &c.

With respect to the effect of high elevation simply, or *per se*, on the frequency of the pulse, when the body is at rest, and free from the influence of the Cordillera sickness, I may just notice, and not from memory, but on the authority of my Case-book, now before me, as written in Cerro-Pasco, in 1826, that in several instances of acute disease among the Cornish miners and mechanics, &c., the pulse is mentioned as being at first full, strong, and frequent (sometimes above 100), and then it gradually comes down to 80 in convalescence, and finally, to the natural standard (72) in cases of perfect recovery. Our usual practice at the mines, however, was to send chronic invalids and convalescents, especially in cases of

rheumatism, chronic pulmonary disease, and hepatic congestion, with obstinate bilious vomiting, to our sanitarium, or great health-resort, the village of Huaraca, eight leagues below the mines, and on the road to Huanuco. But the old Spanish miners, when they found their general health impaired at these haunts of dissipation and gambling, used to resort to the mineral springs at Cono, and the sulphurous baths of Yanahuanca, in the subjacent valleys.

12. "The appetite becomes increased; the thirst is likewise, in general, augmented."

At Cerro-Pasco, the appetite of our Europeans was generally vigorous; and, in after years, when resident in Lima, I always found, in sending invalids from the coast to the mountains, that their digestion improved, provided the drinking water was good and wholesome. But I have no note or recollection that *thirst*, under the ordinary bodily conditions of health and repose, was increased at high elevations; indeed, as compared to Lima, I should say that thirst was little experienced at the mines of Cerro-Pasco, where, at one time, I myself resided for a twelvemonth.

13. "The sanguification is improved."

By removal from the debilitating climate of the capital of Peru, on the coast, to the cereal Andine valleys of equable annual climate, at the elevation of from eight and nine to eleven thousand feet above the level of the sea, the pale, anemic votary of fashionable town life is usually observed to gain flesh, and a ruddy cheek and lip, that are good outward signs of an improved sanguification.

14. "The nervous system becomes invigorated, the sleep, in general, more healthy."

I have myself sent the confirmed hypochondriac of the capital to the height of ten or eleven thousand feet on the Andes, with the most perfect success, and relief from this change of climate; and the martyr to spasmodic asthma in Lima, who can scarcely ever enjoy a perfect night's rest there, is often entirely relieved of breathlessness, and able to sleep comfortably, by changing his residence from the capital to some convenient Andine climate.

15. "The activity and energy of the muscular system became increased."

Within certain limits this proposition is true, also, on the Andes, but not absolutely. The native-born mountain Indian of Peru is a deep chested and firmly limbed little man. He is capable of very great muscular exertion, as has been proved on marches of extraordinary length and rapidity, with only toasted Indian corn for food, and the coca-leaf as a sustaining cordial. He trots, rather than walks, over ridges of the Cordillera, with perfect ease to himself. But, on the other hand, the Creole of the sea-board is not able for the pedestrian feats of the mountain Indian, on the loftier regions of the Sierra. At the elevation of nine or ten thousand feet, the native of the shores of the Pacific as well as the European, may feel his muscular energy not diminished, and perhaps increased, but as he ascends higher and approaches the snow line of the Cordillera, his muscular strength and freedom of breathing are sensibly diminished, and both fail him on any active exertion in climbing or walking, &c. Thus, the Cornish miner failed in muscular power at the mines of Paseo. He could not perform his day's work with the same ease as the native Indian, nor wield the same weight of hammer in the performance of it. But were the circumstances reversed, and the Peruvian Indian transported to Truro, in Cornwall, with the help of all the coca in the world, he would certainly have no chance in muscular energy and power, as matched against the native Cornishman.

16. "The secretion of the skin is most likely augmented."

At high and cold elevations on the Peruvian Andes, it is found difficult to produce perspiration, medicinally, even with the aid of heavy bed-clothes. In warm and dry inland straths—such as that of the beautiful valley of Huanuco, for example—where rain only falls in passing showers, and where, for several months in every year, the night-dew is almost imperceptible, I have observed in my own person, that even during the most active exercise of running, the perspiration was so rapidly carried off the surface of the body, or absorbed by the air, that no inconvenience was felt from it. In climates of so mild and equable a character as this pointed at, it is probable that the average secretion of the skin on the Andes may be augmented.

17. "The urine appears to be not materially altered in quantity."

The climatic influence on this secretion I found to be very remarkable. Descending from the valley of Huanuco to Lima, during the dull, misty, and drizzling months of the year on the Peruvian coast, the calls of micturition were so frequent as to be most troublesome. I think the difference of temperature, in the shade, at Huanuco and in Lima at this season, might be about six degrees Fahr. But in the former place, the air was dry and equable, with abundant sunshine; while on the coast the sky was dull, and the air humid, and produced a sensation of remarkable chilliness, which had the effect of throwing back the cutaneous secretion, and proportionally augmenting the secretion of urine.

ON THE PATHOLOGICAL INFLUENCES.

The type and pathology of diseases greatly vary with elevation, temperature, humidity, and aspect, &c., on the Peruvian Andes.

This subject, however, is far too extensive to be taken up in cursory notes and observations like the present. I may, nevertheless, adduce a few facts in illustration of the influence of aspect and elevation on climate, and, consequently, on physiology and pathology.

Mr. C. R. Markham, in his work entitled, *Travels in Peru and India*, in connexion with the chinchona plant, relates that the climate of Cuyo-cuyo, situated on the eastern aspect or slope of the Andes, in the Peruvian province of Carabaya, is much milder and more tropical in its vegetation than the climate of Arequipa, on the western declivity of the same mountain range; yet Cuyo-cuyo is 10,500 feet, while the city of Arequipa—which is surrounded by a rich and highly cultivated oasis in the desert—is only 7,850 feet above the Pacific. Between this city and the sea is a broad sandy desert, and behind it, towards the Cordillera side, the snow-capped "Misti," with its overhanging mantle of blue, rises to the height of 20,300 English feet. This immense mountain is treeless, and mostly denuded of vegetation, while its arid slopes are covered with volcanic ashes. Dr. Mateo Paz Soldan observes that from the end of May to the first week in August, the thermometer (Reaumur) ascends in Arequipa from 10° to 15°, and that during the remaining months of the year it goes up to 18°, as its maximum in the shade.*

* See *Geographia del Peru*. Paris, 1862.

The daily transitions are sudden, and there is observed in course of the day great difference of temperature between the shady and sunny side of the same street. After sun-down the thermometer often falls 20 degrees Fahr. In December, January, and February, rain falls at Arequipa, but with such marked regularity, that, according to Mateo Paz Soldan (who was himself a native of that city), it only occurs from two to five o'clock, p.m. But let us leave Arequipa, in lat. 16° 20' S., and lon. 71° 32' W., and cross the western Cordillera to the open sugar-growing valley of Abancay, in the department of Cusco, and in lat. 13° 37' S., and lon. 72° 30' W., and at the same elevation above sea-level as Arequipa, we there find a hot West-Indian climate. But, if we again leave Abancay and cross to the Atlantic side of the eastern Cordillera, we find that the relation of vegetation, heat and moisture, to elevation is totally changed from that which prevails on the western side.*

In cases of pure *seroche*, which always depend on an over-attenuated atmosphere, the removal of the sufferer from a higher to a lower level, as from Cerro-Pasco to Huaríaca, at once removes the malady. So far, then, the connexion between vertical elevation and the Cordillera sickness is quite obvious. But in another disease, the limits of which have long been assigned to a few thousand feet above the sea—viz., yellow fever, as seen in Jamaica and Mexico, &c.; the late epidemics in Peru have far extended these limits, and exhibited modifications of a very remarkable kind in connexion with elevation and temperature, &c. For example, when persons infected with this fever arrived in the city of Arequipa from the seaport Islay, many of them died with black vomit; but in each separate case the germ of the disease seemed to have died with the individual. It did not propagate itself or become epidemic in Arequipa, and it has been inferred that this exemption was owing to the dryness of the locality. In the still drier climate of Piura, in N. Peru, the yellow fever epidemic was exceedingly mild; and cases of black vomit were there, as in Arequipa, confined to individuals from the seaport. But, strange to say, this fever, which first showed itself on the coast, and did not, when introduced to Arequipa, spread within the immediate environs of the city, no sooner took effect beyond its suburbs, on the road to Puno and Cuzco, than it proved most mortiferous. At the poor Indian villages, Chihuata and Poci, five leagues to the east, and south-

* See my paper on the Geography of Diseases in the Climates of Peru. *Edin. New Phil. Journal*, Vol. vii., January, 1858.

east, of Arequipa, in a cool climate, at the elevation of from nine to ten thousand feet above the Pacific, the fever committed great havoc, and also extended inland to high elevations, in the department of Cuzco, &c. It is quite true, that at such high elevations on the Andes this yellow fever did not originate; but experience proves that it preserved its vitality and individuality of type in regions where the mean temperature did not fall below fifty degrees of Fahr., and at an elevation of above 11,000 feet. At still higher elevations the epidemic did not cease; but it was observed to change its type more to the form of typhus, without any marked lesion, on *post mortem* inspection, being observed in the stomach or intestines—organs which were notably affected at lower Andine levels, of from 1,800 to 10,000 feet above the sea.*

In the normal atmospheric constitution of Arequipa, catarrhal fever is one of the prevalent disorders of the locality, and it often merges into the inflammatory form. The *tabardillo* fever is one of the scourges of the population. It ordinarily sets in with inflammatory symptoms, and after eight days duration, assumes the low nervous form, with cerebral lesion and prostration of strength. Pleurisy, pneumonia, and dysentery (probably aggravated by the bad river water chiefly used by the poorer inhabitants) are, also, but too common and fatal diseases.^b

Goitre, so abundant in the warm and deep valleys of the department Cuzco, is not once mentioned among the diseases prevalent at Arequipa. Indeed, goitre is properly a disease of the inter-Cordillera glens and valleys of Peru; and, as for *cretinism*, I never, in a quarter of a century, met with as much as a single example of it, either on the coast or mountains of Peru. But, on strict inquiry at Lima (so late as 1859 and 1860) I learned that in the Province of Pataz,^c and in the village of the same name—where goitre is prevalent, and the temperature warm—with a population of 1,500 souls, there are some deaf, dumb, ill-shaped, ugly, and idiotic human creatures, who may be affected with cretinism. But if cases of this kind are ever seen in Peru at the elevation of the Cordillera, or, as

* See article on *Hæmagastria Pestilens*, in the new and abridged edition of Dr. James Copland's Dictionary of Practical Medicine, with its references on the Yellow Fever of the Peruvian Andes.

^b Chicha, or Indian corn beer, is chiefly used, instead of water, by the rural population of Arequipa.

^c The Province of Pataz is full of deep and hot valleys with high hills between, and the goitre is there ascribed to the insalubrity of the spring water used by a section of the inhabitants.

it has been asserted, as high as 14,100 feet above the sea, it must, I think, be a mere incident of travel, and not because the disease is indigenous at the foot of the snow-line. This I have shown more fully in an article titled "Gleanings in Peru," published in the *Edinburgh New Philosophical Journal*—New Series, 1860.

During my residence at the mines of Cerro-Pasco I never had before me but one case of apoplexy. It arose from careless exposure to insolation.

Contrary to what might at first be expected, I have known organic disease of the heart, with aneurism, quite relieved by a removal from the coast to the mountains. This case proved very oppressive, and ultimately fatal, in Lima, to a young officer who, during active military service at the elevation of ten or eleven thousand feet on the Andes, in the valleys of Tarma and Jauja, felt his breathing quite free, and was capable of taking most active exercise.

Incipient tubercular phthisis, usually attended with more or less hæmoptysis, is one of the most common pulmonary affections known in Lima, and other parts of the coast of Peru. It is, besides, a disease almost certainly curable, if taken in time, by removing the coast patient so attacked, to the open inland valley of Jauja, which runs from ten to eleven thousand feet above sea-level.

This fact has been known and acted upon from time immemorial, by the native inhabitants and physicians; and I have myself sent patients from the capital to Jauja, in a very advanced stage of phthisis, with open ulceration and well marked caverns in the lungs, and seen them again, after a lapse of time, return to their homes free from fever, and with every appearance of the disease being entirely arrested. But in many such instances it would, after a protracted residence on the coast, again become necessary to return to the mountains to prevent the recurrence of the malady.

My space will not allow me here to enter on this subject, which I have elsewhere noticed more in detail.*

I may, however, say in conclusion, that at the distance of twenty-five leagues from the town of Lambayeque, on the coast, is situated the Indian village, called Cachen, on the lowest summit of the western Cordillera, as it approaches the shore of the Pacific; and the water-shed falls equally to the east and to the west from this ridge. Its climate produces wheat, potatoes, and pastures, but no

* See *Edin. Med. and Surg. Journal*, No. 144; and also the *Brit. and Foreign Med. Chir. Review*, No. xxxvi., Oct. 1856.

tree except the elder. In the open air at midnight, and in the dry season, the thermometer of Reaumur here fell to 4°, and rose to 7° or 8° by day within doors. In the sun the rise would probably be nearly twice as high as in the shade. Now this is one of the acknowledged health resorts for phthisis and hemoptysis contracted or developed on the coast of North Peru, and cases of recovery at this place are well accredited among trustworthy natives, who have themselves experienced its advantages. But the equable climate of the strath of Huanuco, with a night and day range of temperature from 66° to 72° Fahr. all the year over, is not favourable in similar cases, as I had the opportunity of testing: but at colder elevations up the sides of this Elysian Valley, I have known decided benefit accrue to the phthisical and hemoptic patient.

I am led to offer the above notices on certain Andine climates in reference to tubercular consumption, with and without hemoptysis, and in the white as well as in the mixed races of various shades of colour, such as are usually sent from the coast to the mountains of Peru for restoration to health, as a response to Dr. Hermann Weber's appeal to the whole medical profession for information on the influence of the Alpine climate of Switzerland, beyond the elevation of 5,000 feet above sea level, on consumption, and on the very first stage of this disease. And though the elevation of 5,000 feet in the tropical Andine climates of Peru implies very different physical conditions, as the preceding observations sufficiently manifest, to the same height above the sea in Switzerland; yet, as regards the influence of elevation as favourable, or otherwise, to the production, or removal of, pulmonary consumption, in comparison to localities on the sea-board or lower plains, I think the general question involved in Dr. Weber's inquiry is essentially the same in its practical application on the Andes as on the Swiss Alps.

In regard to Peru, it will be proper always to bear in mind that its great sanitarium for hemoptic and phthisical patients from the capital, is the valley of Jauja, in the central department of Junin, at the distance of 120 miles E. of Lima, and beyond the western Cordillera, in lat. 11°50' S., 75°25' W. The breadth of this valley varies, but it may average ten or twelve miles; while its length is stated to be, little more or less, fifteen Spanish leagues, or about fifty miles. In the harvest season it is delightful to see the whole strath of this vale, to the extent of from forty to fifty square leagues of the most fertile soil, all covered, up to the base of its sloping and pastoral hills, with abundant crops of Indian corn or maize,

wheat, barley, and potatoes, with intervening fields of green lucern, potatoes, and other roots. The river Jauja, which originates in the lake of Chinchaycocha, on the lofty plain of Junin, glides majestically through this valley; and on its left bank (amid numerous villages and hamlets, enlivened and beautified with trees of the most verdant foliage, scattered on both sides of the river) stand the two important towns, named Jauja and Huancayo, which are the principal health resorts for phthisical invalids from Lima. Huancayo enjoys a milder and warmer climate than Jauja, being considerably less elevated above the level of the sea than the latter. At Huancayo, 12° 0' S. lat., and 75° 12' W. lon.; the annual range of temperature in the shade may be taken as ranging from 8 or 9° to 14° Reaumur; while at the cooler town of Jauja, with from 10 to 15,000 inhabitants, the range during one whole year has been observed not to exceed from 8 to 12 degrees of Reaumur, or from 50 to 59 or 60 Fahr.; with a sky always clear and sunny, and an atmosphere pure and bracing, which invites to out-door exercise and enjoyment. The harvest being home, the whole rural population rest from their agricultural labour for eight months in the year, which they give up entirely to amusement and feasting, trusting to the rain of heaven during the other four months in the year to fertilize their land, and yield them more food than they require; so that they never think to extend their toil over the rest of the year by availing themselves of irrigation from the bountiful waters of the Jauja, as they might easily do. But there is no inducement; for the transport of produce to the capital would, in the present state of the roads, cost more than it was worth in the market. (See *Revista de Lima*, Oct., 1859). I think this information may be useful to the European, as showing the climate and topography of the great health resort of the consumptive in Peru. It is probable that ere long the interests of commerce, and the growing facilities of fluvial navigation, will open up the inter-Cordillera regions of Peru to the whole world. Now that a new ocean steam route is about to be opened up by the United States and Brazilian Steam Company, Para, at the mouth of the river Amazon, is to be one of the ports of departure and call—whence Brazilian and Peruvian steamers will run 2,500 miles up the Amazon. Thus, the department of Junin, with its diverse geographical zones, in the provinces of Huanuco, Cerro-Pasco, and Jauja, will, in the natural course of events, become accessible from the side of the Atlantic without the difficulties of the great western Cordillera barrier to encounter:

and a health resort to all the phthisical patients of the world may be easily reached, through a graduated elevation of space and climate such as the face of our globe no where else can equal, in richness of vegetable and mineral products, within the same limits. In further evidence of the importance attached to the climate of Jauja by the physicians, government, and inhabitants of Lima, and the coast of Peru in general, I shall here briefly refer to the "Estadística General," or general statistics of the capital, as published by Dr. A. Fuentes, of Lima, in 1858. He says, on the subject:—"Jauja has always been the refuge of consumptive people, and a lengthened experience has demonstrated the favourable results of its climate." Nevertheless, he well observes, many are disappointed of the benefits they expect from Jauja, because they do not leave Lima for that district until in the last stage of pulmonary decay; or because they do not remain in Jauja the time required by nature to insure a perfect recovery; or because, after visiting this sanitarium, instead of following a methodic manner of life suited to their state of disease, they abuse the advantages of the climate by the very help of the relief they derive from it, and commit excesses which can only lead to their premature death. But the important result, from the best procurable data, notwithstanding such instances of irregularity, is, as stated by Dr. Fuentes, that the proportion between the *cured* and the total number of patients in all stages of pulmonary consumption sent to Jauja, amounts to 79 $\frac{43}{100}$ per cent. And in view of so important a general result to the patients from the capital, where the Indian soldier is singularly prone to phthisis—a disease almost unknown in his native hills—the government have of late years—in 1860—initiated a military hospital for consumptive patients from the coast, and capital in particular, in the vale of Jauja, under the direction and superintendence of Dr. Jose Cobian, himself a sufferer from incipient tubercular phthisis, and recommended by the *Medical Society* of Lima to seek his restoration to health in the valley of Jauja.—See *Lima Med. Gazette*, 15th March, 1860.

The annual rate of general mortality from all diseases among the whole population of Lima, which, by census, is reckoned at 100,000, Dr. Fuentes, on strict medical investigation, estimates at 5 per cent. And, further, from a general classification of all diseases in persons of all ages and sexes, who die annually in Lima, this most intelligent and inquiring author gives us the proportion to this total, 38 $\frac{1}{2}$ per cent. of fever cases; 19 $\frac{3}{4}$ per cent. of dysenteric cases; and the proportion of deaths from tubercular phthisis, as compared

to the gross amount of deaths from all other ascertained diseases, he gives at the high rate of 22 $\frac{3}{4}$ per cent. This being so, we must admit—even should these statistics be allowed to be as yet imperfect—that the physicians in the capital of Peru, in common with all other ranks and classes of its rapidly increasing and variously coloured population, have ample opportunity of testing the *comparative curability* of this disease on the coast and on the mountains, at the elevation of from 5,000 to 10,000 feet, and they have fully and unanimously decided in favour of the latter, provided only the patient be sent there in the early stage of the disease.

D. S. A. Parker

from the Author

"THE BRITISH SOLDIER IN INDIA."

A LECTURE DELIVERED AT THE ROYAL UNITED SERVICE INSTITUTION.

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LECTURE.

Friday, 4th May, 1866.

MAJOR-GENERAL VINCENT EYRE, C.B., in the Chair.

"THE BRITISH SOLDIER IN INDIA."

By Dr. MOUAT, Surgeon-Major H.M. Bengal Army, Inspector-General of Prisons, Bengal, F.R.C.S., &c.

PART I.

The CHAIRMAN: Having been invited to preside on this occasion, I do so with great pleasure, since it affords me the opportunity of introducing my old and esteemed friend Dr. Mouat, who has come to lecture to us on a subject of the very highest importance in connection with the objects of this Institution; namely, "The British Soldier in India."

Dr. Mouat must, doubtless, be already familiar by name and reputation to many here present, as one of the most distinguished members of the Indian Medical Service. During his 25 years of active life in India he has filled several important posts under Government, and has zealously availed himself of the ample opportunities he possessed of acquainting himself with the actual state of the British soldier in the various localities where he is stationed; and, in 1858, he published in Calcutta the result of his observations in an interesting pamphlet, containing many admirable suggestions for improving the moral and sanitary condition of our soldiers in India, which may probably have conveyed some useful and timely hints to the Commission then about to sit in England for investigating these matters.

Since that period, however, vast changes have taken place in our Eastern Empire. The old East India Company's rule has passed away; their European Regiments have been amalgamated with the Royal Army of Great Britain; the total British Force in India has been more than doubled in strength; and, although much has been already done to rectify old errors and to improve the condition of our Barrack life in India, it is generally admitted that very much more still remains to be effected; and I am sure that Dr. Mouat (whom I now call upon to

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commence his lecture,) will have much to communicate that can hardly fail, not only to interest and instruct those now present, but also to impress beneficially those public officials who possess the power and influence through which alone his suggestions can be carried into practical effect.

Dr. MORAY: General Eyre, Ladies, and Gentlemen, I do not think I ought to feel indebted to my friend General Eyre for raising your expectations to an extent that I am afraid I shall disappoint. However, General Eyre has told you—and I think told you correctly—that there are few subjects connected with the British soldier that at the present moment are of greater interest and importance, than everything relating to the European force in India. Not only is a large portion of the British army—probably not less than from 50,000 to 60,000 men—likely to be permanently employed in that country, but the maintenance of our empire in India depends upon the gallantry and upon the good and soldierly conduct of this army. There can be no doubt whatever that India is at present a military empire, so far as we are concerned, and that it must continue to be so for many years to come. It is essentially an empire of the sword, and not an empire of opinion. It is quite true, as the late Sir Henry Lawrence, one of the best soldiers the Indian army ever produced, said in an article which is contained in an early number of the "Calcutta Review," that "one good magistrate may be better than a regiment; one sound law better than a brigade;" and that the administration of wise laws may effect works that armies would fail to accomplish; but unless the British soldier were there to support the magistrate, and to aid him in administering those laws, I fear that our hold upon India would be small indeed. Those who ever laboured under a contrary belief must have been satisfied from the results of the Sepoy Mutiny of 1857 that our hold upon the country depends rather upon our military strength than upon the affection of the people for our Government, just and equitable as I believe our rule for the most part to have been.

In proof of the interest and importance of the subject, may I ask you to cast your eyes upon this skeleton map for a few moments with me, and you will at a glance perceive the vast responsibility that falls upon the British army in the performance of its duties in connection with India. Upon this map all that is coloured red in its various parts belongs to the British Government. There are a few patches here and there coloured differently that are at present either tributary, or remotely dependent, or, in some instances, entirely independent of that Government—to their great misfortune, for if, in my humble judgment, there be any event in their past and recent history that has been more valuable to any portion of that country than another, I hold it to be that its rule has been assumed by the British Government. Take, for example, the important province that was last added by one of the greatest rulers India ever saw, the province of Oude—the annexation of which province was supposed, in a great measure, to have led to the mutiny; a supposition I hold to be incorrect. Contrast the condition of that fine province, now that it has been for a very short time subject to British rule, with the state in which it was only a few short

years since, as described by Sir William Sleeman from personal observation; and I think it is impossible for any sensible and unprejudiced man to deny that the greatest benefactor that country ever had was the late Marquis of Dalhousie.

In speaking of the British soldier in India, you will readily understand then how difficult it is for any one to treat the subject so as to condense a title of the information which has to be communicated regarding it, within the short space of an hour. You will perceive that the English possessions in Hindustan are bordered on nearly three sides by vast mountain ridges, rising in some places to a height of some four or five miles above the surface of the earth—some of them the highest mountains in the world. Fortunately for us, for reasons connected with the immediate subject of this lecture, which I shall presently refer to, there are likewise lower mountain ranges, intersecting the country in every direction. In addition to these, it has vast alluvial plains, all of which possess peculiar characteristics in relation to the health of the soldier and of the Europeans generally who reside in them. The delta of the great rivers of Bengal, in the low lying plains of which is supposed to have originated that terrible disease that has more than once spread over Asia and Europe, and is even now threatening us with another invasion, is one of the most extended and important of those plains. Again, if you follow my pointer you will see a sea-board, bounding both sides of the Bay of Bengal, extending Southward in its Eastern side to Cape Comorin and running up again to the North with a very short interval to the province of Scinde, which was added to the British Possessions a few years since by one of the greatest English Soldiers who ever served in India—the late Sir Charles Napier. The whole of the vast extent of territory which I point out, is under British rule. I believe the mountain ridges to measure some 4,500 miles in length; the Coast line to comprise 3 or 4,000 more; and no less than 1,500,000 square miles of inhabited territory to depend upon the British Soldier for the allegiance of their populations to the British Crown. India is peopled by different races, not numbering less than 150,000,000, so distinct from each other, that it would be as correct in speaking of any portion of Europe, to confound the Englishman with the Spaniard, or with the inhabitant of Southern Italy, as it would be to speak of the inhabitants of any given portion of Hindustan, as identical with the inhabitants of any other portion.—There is a much wider difference between the Bengali and the Beloochee, the Mugh and the Mahratta, the Southal and the Seikh, than there is between any two nations of Europe.

Fortunately for us, the lower and more unhealthy provinces in every direction are inhabited by the least warlike people in the country. They are generally more or less timid races, who are easily held in subjection, do not possess the means, and are destitute of the qualities likely to prove the prowess of the British Soldier in the field. Hence, in a strategical point of view, for the maintenance of the rule of the British Government in India, it is not necessary to station large numbers of British Soldiers in those climates which are most injurious to their health. I will not say more upon this point, because the mili-

tary defence with special reference to the topography of Hindustan, would alone occupy more than the time allotted to a single lecture. I admit freely that the teeming population of India is chiefly kept in order by the mild and beneficent rule of the British Government; for I believe that Government to be in every sense a paternal, and so far, a model Government, and I know, from long residence in the country, that it strives to do the duty assigned to it, in the manner best calculated to secure the contentment and happiness of the peoples committed to its charge. Among them are, however, a considerable number of warlike and some fanatical tribes, and there is a Mahomedan population, probably numbering not less than 30,000,000 souls, who from the very nature of their religious tenets, cannot be well affected towards a Christian Government, however just and equitable that Government may be towards them. It is foreign to my purpose to enter further into this question, and I only thus briefly refer to it to show how onerous is the duty of, and how great are the interests confided to, the British troops serving in India.

Now, with regard to the British army in India, you will all remember, or most of you probably will remember, that in the year 1859 a Royal Commission was appointed to investigate the condition of that army. After labouring for three or four years, it produced the mass of evidence which is contained in the two thick folio volumes now on the table—one of the most valuable and exhaustive documents ever published on any subject. It has been my good fortune, for I hold it to be so, being connected so intimately as I am with India, to have had access to, and to have studied carefully the contents of this storehouse of facts. I shall not however, alarm you by opening these volumes, or by attempting to communicate any portion of their details to you. The mere bulk of the volumes is quite enough to repel you from any further acquaintance with them, beyond a statement of the chief revelations which they contain, and which it is my duty to-day to prove to be no longer a true picture of the British Army in India. At the time this report was published it presented a very gloomy picture, indeed, and would lead one fairly to infer—for I must confess that, from the data which at that time had been accumulated, no other inference was possible—that there was terrible mortality, and a distressing amount of preventible sickness among the English Soldiers in India—that their lives were a constant struggle with illness and ennui—that their existence one of perpetual purgatory in all its relations—that they had no fit places to live in—that the various stations in which they were condemned to pass the best portions of their lives were so undrained and unhealthy, so wanting in all the conditions of health, as to be better fitted to destroy than to preserve the soldier. The mortality was said to be—and no doubt it was true of the period embraced in the report—no less than 69 per 1,000. That was a very startling fact, and would alone represent a vast amount of misery inflicted on the English soldier by service in that country. In addition to the 69 per 1,000 who were destroyed, there was likewise a large percentage whose health was permanently ruined, and who were sent from India to end their days in poverty and misery at home, for

poverty and misery are unhappily the inevitable end of the career of most sick and worn out soldiers.

Now, although this was all correct at the time the report was written, a great change was even then being effected in the condition and management of the European Soldiers in India.

We live in an age in which a large amount of sensation appears to be necessary to direct and rivet public attention to any particular subject. A railway for instance may be mismanaged to any extent, and people be subjected to constant avoidable risk from such mismanagement, but until it kills a bishop or maims a Prince of the Blood, or until some shocking catastrophe startles the public from its repose, little notice is taken of railway misrule with a view to its remedy. So it has been with regard to the army. To my certain knowledge, ever since I have been in the service, and from records to which I have had access for periods long anterior, the various matters that are contained in the report of the Royal Commission have been recorded as earnestly as it was possible for men to state them, by my predecessors, and by my contemporaries, both in Her Majesty's and in the Indian Medical Services. There is scarcely a single recommendation contained in this report that has not been urged in some form, over and over again. But you will ask me fairly, why, attention having been drawn to the facts, remedies were not applied to diminish or remove the evils? The fact was, even in England itself, so long had Europe been at peace, and so little attention was paid to these matters, that, until the Crimean war occurred, and the whole nation was startled by the revelations that then took place, of the great sickness, lamentable mortality, and heartrending hardships to which the soldier was subjected, public attention was not so forcibly directed to the matter as to lead the rulers of the nation to devote the amount of attention that has since been paid, with the happiest results, to every question connected with the moral and material welfare of the soldier, whether in India or in England.

It is also a singular fact, which has been very long known, that the actual destruction of life from war either in battles or in sieges, or in the purely military contingencies to which the soldier is liable, are infinitely less in any campaign that has ever occurred, than from the other agencies which assist in his destruction. For example, not to go back to earlier wars, of which the statistical details are less reliable and accurate than those collected now-a-days, I have placed on the table a report published in Paris a few days ago. It is a statement addressed by Dr. Chenu to the Council of Health of the Army of France, upon the results of the Crimean War as regards the French Troops. From it I have selected,—I am not going to weary you with a dreary array of dry details,—but I have selected a very few figures, to show that, even with all recent inventions and improvements in arms of precision, the other destructive agents banded together against the soldier in the field are infinitely more terrible than those which have hitherto been discovered and used by man. Dr. Chenu has shown that the following were the losses sustained in that short campaign—a campaign brief in duration, yet one on the whole that

reflects much lustre upon the British Arms, although purchased at a lamentable sacrifice of human life. The English army, which appears to have sent, from first to last, rather more than 90,000 men to the field, lost 2,755 men killed in action. There died of wounds or disease, afterwards, no less than 19,427—not far from nine times as many as were destroyed by the enemy—making a total loss of 22,182 men. The French army, again, which sent there, from first to last, some 309,268 men, lost, in killed on the field of battle 10,240 men, while those who subsequently died of wounds or disease numbered no less than 85,375; making a total loss of 95,615 men;—a very dear price, indeed, at which to purchase the continuance of such an Empire as that of Turkey. In addition to this, the losses in the other armies must be brought into the account to estimate the cost in life of that War. The Piedmontese, who were few in number only had 12 killed; but 2,182 of them died from disease or wounds. The unhappy Turks, from 1853 to 1856, had 10,000 men killed, and 25,000 men destroyed in other ways. But the loss of the great aggressor in this war transcends that of all the rest put together. The Russians are supposed to have lost in action, from 1853—1856, 30,000 men, and from disease and the dangers and hardships to which their armies were subjected, not less than 600,000 men. The Russian loss is therefore estimated at 630,000 men by Dr. Chenu. Although not quite positive in regard to these figures, the reporter had reason to believe that the number given was rather under, than over the truth. So that the whole loss in that campaign, which occurred only the other day, and some of those who took part in which are probably among our audience to-day, shows that there were killed in action 53,000 men out of that armed host; and that there died from various causes, including wounds, no less than 731,984 men!

This points very strongly and significantly to the fact then that there is no need to cross the world to India to discover destructive ~~things~~ against which the soldier has to contend whether in or out of the actual field of battle. It leads one to marvel much, that, while vast sums of money are expended in rifling cannon, in perfecting guns of every sort and description, so little money comparatively is devoted to saving the lives of the soldiers from other agencies, the losses from which are infinitely greater than any number that arms of precision are capable, or will ever be capable, of destroying.

There is one little fact connected with the Crimean report which it gives me the greatest possible pleasure to mention, because it comes from an unexceptionable source.—It is the tribute borne by our gallant neighbours to the efficiency of the Medical Department of the British army in the Campaign referred to. I have translated a very short passage from Dr. Chenu's work, which is to the following effect:—"I had finished my work when I had the good fortune to receive a communication of an analogous work accomplished in London for the English army. I have translated the numerous tables which it contains, and I must confess that I have been unable to attain the astonishing precision of my brethren of the English army. This precision which could scarcely be attained in the great Hospitals of

France in time of peace, leads me to suppose the existence of admirable and almost incredible method and arrangement from the beginning and during the whole course, of the war in the English field and fixed hospitals; and if, as I dare not doubt, the statistics of the Medico-Chirurgical Service of the English army are scrupulously exact, it must be admitted that our brethren have been more skilful and fortunate than we have." This testimony is indorsed by no less a body than the Imperial Institute of France,* which also bears testimony to the success of the British Army Medical Department.

Now, I am somewhat puzzled how to begin the special consideration of the particular subject which it is my purpose to illustrate to-day, particularly as I am horrified to find that no less than half the allotted time has already elapsed. I will ask you briefly then to look "on this picture and on that." In my hand I hold a report that has been printed within the last two months, by order of the House of Commons—the report of the Bengal Sanitary Commission, showing the condition in which the British Army in India is now, as contrasted with the state in which it was when Lord Stanley's report was printed, the ink of which we may, without much metaphor, say is barely dry—for only three short years have elapsed since it was published in 1863. Regarding the mortality of 69 per thousand recorded by the Commission, with no less a man than Lord Stanley at its head, a hope was expressed that by the various sanitary measures and improvements of different kinds recommended by them, the death rate of the British Soldier in India might, at least, be reduced to that of Her Majesty's Guards in London at the time the first Commission sat, 20·4 per thousand. They hoped that by improved sanitary arrangements thus much might be accomplished, and that, ultimately, a still greater saving of life might be attained. Now this report of the Bengal Sanitary Commission, written by Mr. John Strachey of the Civil Service—and I have the greatest pleasure in bearing testimony to its excellence and the ability exhibited in it, the more especially as it verifies the statement made in the beginning of my lecture—this report I say, shows that the mortality of the army in India, at the present moment, is already reduced to the standard that Lord Stanley's Committee believed to be attainable by the introduction of measures that would take some time to bear fruit. The death rate at the present moment is as small as was that of the Guards in London at the time the first inquiry took place, after the Crimean War. To have descended from 69 to 20 per thousand is a vast jump, and Mr. Strachey has shown, by the facts and figures contained in his record, how this has been done. It has not been by Sanitary Commissions, or by any other non-professional body, that this improved state has come to pass.

* In the memorandum of the French Institute, stating the grounds for awarding the statistical prize of the year to Dr. Chenu, the proportional difference between the French and English mortality is stated to be not so great as the figures seem to indicate, inasmuch as the English returns contained only the mortality in the East, and did not account for those who subsequently died of their wounds in England, while in the French statement every wounded man was traced to his cure or death, wherever they occurred. The reporters go on to say: "Il faut néanmoins reconnaître que le Service Médical Anglais a eu le plus de succès."—F. J. M.

The moment public attention was strongly directed to the matter, a multitude of circumstances which had repeatedly been brought to notice, and had been as often overlooked or disregarded, were carefully attended to. When the medical officer was listened to, and his counsels followed, the amendment began. It commenced before the report of the Royal Commission was written, it continued during the progress of the enquiry, and it anticipated the institution of Sanitary Commissions. The state of the British Army, at the time the report of 1863 was published, was very different from the statement contained in the report itself; and, at the present moment, it is vastly better than anything that could have been expected in so short a time. The credit of this seems to me fairly to belong to the Medical Department of the army, whose recommendations, when carried into effect, have been followed by benefits which medical officers of experience predicated long since, and which are the strict logical results of the practical application of the doctrines of medical science.*

While speaking, however, of these improvements it is necessary to bear in mind the simple circumstance to which much of the amendment is due, and which needed little knowledge of science to accomplish. Sir Charles Napier said some years ago, in one of those quaint and forcible utterances he was in the habit of using, that climate was held responsible for a good deal that climate deserved no blame for, that gin and overcrowding were the real destroyers of the soldiery. It was so in reality. As respects overcrowding, we need not travel so far as India to witness its ill effects. If you cram two or three people into the space that one only ought to and can occupy with safety, you produce not only a state of atmosphere that conduces to disease, but you produce disease itself. One of the most remarkable cases of the kind that I know of is mentioned by Dr. Tardieu, in his "Dictionnaire d'Hygiène Publique." He states that from the year 1843 to 1847, whenever King Louis Philippe went to St. Cloud, the number of soldiers who were attacked by and died from virulent typhoid fever was very considerable; that a disastrous epidemic broke out on every occasion eight days after the arrival of the King; but as soon as His Majesty left St. Cloud, and returned to Paris, the fever disappeared, and the troops became healthy. How was this produced? The condition of the soldier was the same—his food the same—his clothing the same—his duty the same, except that there might have been more pomp and parade when the King was present, than when he was absent; but beyond that, he was not exposed to any of the vicissitudes of war which could account for this unusual sickness and mortality.

* In the Bengal Presidency in 1864, of the 54 stations in which there were English soldiers, the mortality of 41 was below 20 per 1,000; in 12 it was under 10 per 1,000; and at 7 only did it exceed 25 per 1,000.

In France the military mortality is 10.8 per 1,000 for officers, and 22.3 for men, giving a mean death rate of 19 per 1,000, or one per cent. ~~above~~ the present Bengal rate.

In the West Indies French soldiers die at the rate of 75 per 1,000; in Algeria of 70 per 1,000; and when formerly employed in Egypt their loss was 69 per 1,000.—F. J. M.

What then was the cause? It was this: the garrison contained 400 or 500 men for whom there was ample space in the barracks when the King was absent, but when the King was present, 1,200 men were packed into the same space. They were overcrowded in fact, and began to sicken and die rapidly, as they do everywhere in similar circumstances. The same thing occurred in India; and the moment more room was given to the soldiers, and they were not crowded into a space which rendered the barracks pestilential, other conditions remaining unchanged, they immediately began to improve in health. I could give you hundreds of examples of that sort if it were necessary. I will mention one. There is a station near Calcutta, called Dum Dum, which used to be the Head Quarters of the Bengal Artillery, and which for a large number of years was a healthy station. As long as it was only an artillery station, it stood very high in the standard of health, although surrounded in every direction by rice fields and low, swampy ground. From the exigencies of the service, at the end of the second Sikh War, a larger body of troops was ordered to Dum Dum than the barracks were capable of containing with safety. I saw the 70th Foot march to Dum Dum on the very day that Sir Charles Napier, with whom I was at the time, landed in Calcutta. What occurred to that Regiment? A station in which the health of the troops had always been remarkably good, immediately began to deteriorate; and in the first year of its residence there, the 70th Regiment lost 25 per cent. of its strength, simply from crowding into a barrack that was otherwise healthy, and only capable of accommodating a third of the number then squeezed into it. I could multiply cases of a similar kind if I had time. For instance, one of the prisons under my charge, the jail at Mojdapore near Moorsheadabad, was abandoned in consequence of its extreme unhealthiness and reduced to the status of a lock-up. All long term prisoners were ordered to be removed in consequence of the frightful mortality which prevailed, and necessity alone caused to be retained there a few men under trial, or of very short sentences. The prison went up immediately in the sanitary scale and became healthy, although it continued to be one of the worst built and worst placed prisons in the country. Save the numbers confined in it, everything remained unchanged. The drainage and conservancy were as bad as ever, and all the conditions of unhealthiness were the same as had previously existed; the absence of crowding was the sole difference. You might, in fact almost construct a sliding scale of the health of barracks and prisons from this condition only.

The first end accomplished has been more breathing room, and admirably has it answered. Many other improvements are, however, being gradually effected, and most creditable they are to the Government. There is no less a sum than £10,000,000 to be expended within the next four or five years in the building of new barracks or in remedying the defects of old ones. Each section of a barrack is to be separate and detached, and to contain no more than one company. This company barrack again is to be divided, with a room in the centre; and, what we have all been urging for years and years, namely that in a mala-

rious country barracks ought to be well raised above the ground so that the men shall sleep out of the reach of the noxious exhalations from the earth, has been or is to be carried out. The soldiers' sleeping-room is to be a sleeping-room only; his day-room, his drill-room, his dining-room, his smoking-room, and his library are all separate from his sleeping-room.

What is the state of health in England itself of a manufacturing population where they are obliged to pig together in the same room; to eat, drink, sleep, smoke, and swelter, and thereby produce the thousand abominations that pollute the atmosphere they are compelled to breathe? Why, they die to an extent which horrifies the public, the overcrowding rendering them an easy prey to disease. This has been, to a considerable extent, the state of things with our European soldiery in India; and there is no better means of removing these effects than to diminish the number occupying the same room, so as to allow each a sufficient quantity of pure uncontaminated air to breathe. There are other sanitary conditions that are now equally attended to. Drainage is carefully regulated. Gardens are being established in which the soldier may amuse himself and gratify his taste, if he has any, for such pursuits; and, what is of still more importance, in which he can grow a large stock of the fresh vegetables, so necessary for his healthy nutrition. Instead of the dread monotony and ennui, the consuming idleness which drives the soldier to drink, under a recent order of Sir Hugh Rose, workshops have been opened. Soldiers have been encouraged each to adopt some handicraft, probably the one in which he was brought up before he was enlisted; and a late General Order of the present Commander-in-Chief in India, has shown, that a very large amount of success has attended this movement. There is no longer the same excuse for idleness and want of occupation and the barrack has ceased to be the worst form of Castle of Indolence. To a soldier whose daily routine of life consists simply of his drill, and purely military duties, without any occupation for the remainder of the day it is scarcely possible to imagine a more dreary life. There are other conditions also that are gradually undergoing change and will, ere long be established for improving the health of the British Soldier in India. But let me earnestly impress upon you the fact that before any of these things have become accomplished facts—before a shilling of the munificent grant for barracks has been expended—before any of the excellent recommendations recorded in the Bengal Sanitary Report have been carried into effect, the condition of the English soldier in India has improved so much, that he is now in as good a sanitary condition, estimated by actual casualties, as Her Majesty's Guards were in London in 1857.

Another matter of very considerable interest and importance is the condition of the wives and children of the European soldiery. This is a subject deserving of the gravest consideration. The mortality among European women and children in India, is still very large—cruelly large. I am unable, however, to understand how Major O'Reilly the other day in the House of Commons, in speaking of the necessity of the rapid relief of troops in India, came to make a

statement which is unintelligible, and must surely be an error of the press. I have here a copy of his speech, as reported in the "Times." He says "The mortality among the women is no less than 276 per 1,000, and among the children 516 per 1,000;" that is to say in whole numbers that one out of every four women dies annually, and that one-half the children born, perish every year. Where this statement could have been obtained I cannot understand. It is certainly not contained in Lord Stanley's report, nor is it to be found in that of Mr. Strachey. The rate of mortality among the wives and children of the soldiers is nevertheless sufficiently high. It seems to be about 44·5 per 1,000 among the women, and 90 per 1,000 among the children. Great as these numbers are, I have not the least doubt that they are susceptible of very considerable diminution even in the plains; and that the health both of the women and children may be improved, if the same means are applied to better their condition that have been applied successfully to the soldier himself. For instance, the mortality among English ladies, the wives of officers and civilians in India, scarcely rises above 14 per 1,000, as has been ascertained from tables constructed for the different Military and Civil Funds. But you must remember that the unfortunate wife of the soldier is in a very different position from her more happy and more prosperous sister. In the first place, the wife of the soldier is not a selected life, as that of the man himself is. The soldier marries the woman of his choice and there is of necessity no care taken that she shall be a picked life or a healthy subject. Again as a rule, they marry much too early in life. In other respects the hardships they used to suffer in barracks were very numerous and severe some years ago. I remember on one occasion, in 1840, when I was staying with the late Dr. Murray at Madras, at midnight information reached him that great sickness had broken out in the married quarters at Fort St. George. He went immediately, and I accompanied him, to see them, and anything more pitiable than the vast number of human beings whom I then saw crowded into a small space without any regard to the ordinary decencies and proprieties of life, it is hardly possible to imagine. Another case I may mention, that came under my own observation. When I was stationed at Fort William and in medical charge of its garrison, in the same year, the same thing occurred. A dreadful fever broke out, and in one large room in which forty or fifty families were crowded together, I was obliged to insist that every partition should be removed in order that some air might find its way to the corners and nooks of the room that the women and children might not perish from actual suffocation. All that is, happily, now a thing of the past. The effort that is being made to provide comfortable quarters for the women and children will no doubt improve their condition materially, and very soon exhibit a diminished rate of sickness and mortality.

The question of the children is a difficult one, and I am afraid that as long as they remain on the plains of India, the difficulty will not be entirely solved by any change that can be made. We need not, however, be surprised at the high rate of mortality of European

children in India, for I have looked at the latest records to which I have access, and find that the mortality of French children of pure European parentage in Algeria is about 93 per 1,000; very nearly, or, rather above the Indian average, great and dreadful as that is rightly considered to be. Mehemet Ali, who had 90 children of his own, was only able to rear 4 of them in Egypt, showing that the mortality in tropical countries is very great even among the young who are placed in much better circumstances than the child of the English soldier in India ever can be in the plains.

The fact is, that India is a singularly healthy country for well cared for European children up to 4, 5, or 6 years of age, as I believe my experienced medical brethren now present will concur with me in thinking. But after that they begin to pine and fade, they grow up thin and weedy, become scrofulous and die off rapidly, unless removed to England or the Hills. It is very easy to remedy all this for the children of the soldiery also. As I have already mentioned, Nature has provided the antidote to the evils of the plains, by girding those plains with high ranges of mountains. At a height of some 5,000 or 6,000 feet, there are climates the very finest in the world, in which, I have no doubt, that a healthy, vigorous, and manly population may be raised; one that shall enjoy as high a standard of health and physical development as the same class can possibly do in England.

An objection which has been urged to this is, that you may raise white men and women in these hills, but that you cannot raise Scotchmen, Englishmen and Irishmen, although their parents may have come from those countries. That is only true to a certain extent. You certainly cannot raise Englishmen, Scotchmen and Irishmen in tropical countries; but by education and all the surrounding influences which mould the minds of the young, I am of opinion that a European population can be raised on the hills of India, as manly, and in every respect as intelligent as their ancestors in this country. We do not hear of any degeneracy of the Highlander in Canada, or of the emigrant in New Zealand; and we also know that in all countries of the world, there is a natural tendency of mountain ranges to produce a sturdy and warlike population. I have not the least misgiving whatever, that if the scheme which I have always advocated were carried out, namely, the establishment of military colonies in the hill ranges of India, we should find therein the solution of one of our greatest political difficulties in India. If that were carried out, I doubt not also that a vast portion of this unhappy mortality might be prevented; and that the death rate might be reduced to the standard of the same class of the agricultural population in England, both as regards the women and the children.

There are various other matters to which I should like to have alluded, had time permitted. For example, clothing and equipments. There is no doubt that these must be modified to a certain extent with reference to climatic influences. Arms and accoutrements require a corresponding degree of modification. There are conditions of climate which render it necessary, as General Morris said the other day of the wear and tear of campaigning, to dispense with everything that is

merely showy and ornamental, and to restrict ourselves to all that is of real, practical use, and which cannot be destroyed by climate or, by the other destructive agencies that are always at work upon them in India.

This reminds me of a statement which has been in circulation recently—it is only incidentally connected with my subject—with regard to arms of precision, breech-loading weapons, and rifled cannon, that the tendency of them would in the end be to cause battles to be fought like duels at long ranges, in which the leading qualities of the British soldier would be lost. This opinion was first promulgated by Sir Charles Napier, than whom probably no man ever saw harder fighting. I believe the contrary, however, to be the case. When I was at Chalons in 1861, shortly after the Italian campaign, a large number of the French regiments engaged in that campaign, and particularly in the battle of Solferino, formed part of the camp. I asked the question of the French officers, "What had been the result upon the conduct of these battles of long distances?" They told me distinctly that it had led to duels at long distances! "Has it led to duels at long distances?" They told me distinctly that never in the whole experience of the French army, had the bayonet been so freely used and with such disastrous effect as on those fields. As General Morris told us the other day of the recent American war, after the first blaze of fire was over, there was a pause, the lull that precedes the storm, then a cheer and a rush, and the works were taken! It was the same with the French. They closed as rapidly as they could, not depending upon the distant fire. After all, it is the pluck and training of the man who carries the weapon, rather than the mere qualities of the weapon itself, that continues to, and probably will for ever determine the fate of battles.

As regards clothing I can say but little. The only special matter of extreme importance connected with it is the head-dress. There is no agent more active in the production of disease and death in India, than the sun which strikes the soldier from above; and all the devices which have hitherto been resorted to for producing a perfect covering for the head have been more or less failures. The hideous helmets now worn by the soldier in India, whether made of pith (sola), or with a cane foundation, are defective in one of the chief requisites of the soldier's head-dress in the tropics. It should be, as General Morris said, not only his fighting cap, but his night cap. It is impossible for him to sleep in a helmet of any kind. I believe myself that some modification of the turban will, after all, be the best solution of the difficulty. Mr. Jeffreys, who has written upon this subject, and who gave to the Royal Commission a large amount of ingenious evidence, perfect so far as theory is concerned regarding it, recommends highly polished metal helmets on the ground that a highly polished surface reflects light and absorbs little, if any, of the heat of the sun's rays. There is no doubt however, that the weight of such a head-dress is a great obstacle to accuracy of fire; and besides in a climate like that of India all metallic surfaces soon become dull and dingy, and a helmet, without its polish, would, on a bright, hot, tropical day addle the soldier's brain. Therefore no sort of helmet or metal covering will ever in my opinion, answer in a hot climate. With regard to the

hair of his head, he is recommended by General Morris to cut it short, to dispense with brushes and combs altogether, and to depend for keeping it clean upon soap and water. So said also Sir Charles Napier. You may remember when he was sent to India a few years ago, according to "Punch," his baggage consisted of two shirts, a towel, and a piece of soap. He himself has said, "Why should a soldier have more coats than the commander-in-chief? I can do with one, why should he not be content with one?" To return, however, to the hair. I remember many years ago that a wag, who had charge of a batch of Cadets sent to Benares, led them to believe that hair was injurious in hot weather, and that the regulations required them to have their heads shaved at that season. Thereupon the boys had their heads shaved before reporting themselves to the general. When they went to the general's bungalow the officer who had charge of them put on his wig in the ante-room, and then introduced the cadets with their shaved crowns to the astonished general.

There is one other circumstance connected with the head-dress which I ought to mention, and which I think has been a departure from the right road. I see that most of the soldiers of the artillery and cavalry, and probably of some other regiments, now wear no peaks to their caps, and thus expose the head completely. However dandified it may make them appear at home, it will I am certain, be found dangerous in a country like India where the soldier requires every possible protection from the sun for his head and brain. The report of Mr. Strachey mentions that deaths from sun-strokes are on the increase, and it will probably be found on inquiry that much of it is due to the non-protective cap the soldiers wear. The old peak was useless, and anything but becoming in appearance; but the straight peak of the French kepi is not liable to the same objection, is certainly a screen from glare for the eyes, and is just as necessary as the curtain which protects the back of the neck from solar heat.

The form of the boots again is of great importance; and there is the subject of food and drink, on which much might be said. But the only remaining topic which I shall be able briefly to consider is that of acclimation. Is it possible for the British soldier to be acclimated, that is to be able to stand the wear and tear of an Indian climate without injury to health? Can he attain to the same standard of health as that of the soldier in England? In the plains of Bengal, and of all alluvial districts he certainly would not. In the lower provinces he has to contend against an enemy that is ever active, and which there is no means of altogether avoiding, so long as the causes that call it into existence are present, namely heat, moisture, and the luxuriant vegetation, the decomposition of which produces malaria. We have evidence from the experience of Arctic voyagers, and from the evidence of African explorers, of the very varying conditions of temperature and climate which civilised man is able to bear, by accommodating himself somewhat to the change of circumstances in which he is placed. But this has a limit, and beyond that limit it is impossible for a native of Great Britain to become acclimated in Hin-

dustan. There is no doubt, however, that he may become seasoned, and, as a seasoned soldier, be better able to bear all the burdens the climate imposes upon him than the raw and unseasoned recruit.

It is most important, and many officers have insisted upon it for years past—one of them is now present Dr. John Macpherson, who has written strongly regarding it—that no growing lads, or boys of any description, should be sent to India, until the whole of their drill is completed in Europe, and their military duties are thoroughly learned. Growing lads are the most sickly of soldiers, and it is amongst them that the greatest amount of sickness and mortality occurs; but this is likewise the case in European armies.—Most of us have read of the large army collected at Boulogne by the first Napoleon, for the invasion of this country. By constant and careful drill and exercise, it became one of the most efficient forces ever assembled in the field. When he broke up his camp on the coast of France, and marched his army rapidly some 400 leagues, to fight and gain the great battle of Austerlitz, they scarcely left a man in hospital, or a straggler on the road, because they were all thoroughly trained soldiers, not one of them was a growing lad or a man under 22 years of age. Another army which under the same chief, in the year 1809, marched but a short distance to Vienna filled the villages and encumbered the roads with their sick and dying, simply because the troops consisted of growing lads, who were unable to bear the strain of war, or fatigue of marching. Many of them were under 19 years of age.

Another period of life, at which it is impossible for the soldier to bear up against these influences is after he has passed the age of 40 years. But the soldier's career is generally included in the interval between the ages of 20 and 40, as his period of service is seldom prolonged beyond the latter age. It is certain that after 40, the soldier bears transplantation very badly. In India the great resource against climatic deterioration is our hill stations. If the soldiers in India were sent to the hills in larger numbers, and more frequently than they now are, there is no doubt that the necessity, on the score of health, of frequent reliefs from Europe would be obviated. The standard of health at these hill stations is very remarkable. At Darjeeling there is a school for children, which has been established ever since the station has existed; and from that hour to this, although many of the children were sent up sickly from the plains, not a single death has occurred from disease contracted in the station; yet they are of the very class of children who die in multitudes in the plains. The same may be said of the soldier himself. But the influence of the hills in his case is now known to be rather preventive than curative; therefore it would be better to send him there to recruit his health before it has given way, than to wait until he becomes diseased, and send him up to die, as too frequently happens at present.

This leads to another point which I should much like to have discussed had time permitted, namely the cause of the great difficulty in recruiting the army in India at the present moment, and the means of obviating this difficulty. There can scarcely be a doubt that in some, probably in a large degree, unwillingness to incur the risks of an Indian

climate is, in a measure, at the bottom of the paucity of supply of soldiers. It is certain that, from various causes, the army in India is not so popular, either with the officer or with the soldier, as it was in the days when the Indian Empire was under the charge of the East India Company. I do not mean to say that the withdrawal of a large portion of the army from the immediate authority of the Crown, was ever a right and proper thing—or that any sane man would for a moment advocate the restoration of the form of Government swept away by the Mutiny, by no means the least beneficial result of that disturbance. At the same time many of those best acquainted with India are of opinion that as respects the army, the transfer might have been differently managed, with advantage. India is a peculiar country, and differs widely from all other portions of the British Empire. To render any body of men contented to spend a large portion of their lives in places where, for several months of every year, mere physical existence is a pain, it is necessary not only to pay them highly, but to give them an abiding and personal interest in the country, and its people. This can only be accomplished by a permanent force, such as was the European section of the Company's army, every man of which was content to spend the active years of his life in the tropics, and had made up his mind to do so before he left his home. It was emphatically a contented army, in which the greatest punishment that could be inflicted upon the soldier was expulsion from its ranks. The same is not the case now. Both officers and men are restless, and all who have not formed permanent ties binding them to the country, seem to be more anxious to leave than to remain in it. The race of men who conquered India, who were proud of their connection with it, who were content to bear patiently all its risks and minor miseries, and were prepared, in many instances, even to end their days there, has passed away: and so far as my personal observation permits me to express an opinion regarding it, as yet they have found few successors. Home sickness is the great moral endemic, and it is on the increase.

The present state of the European Army in India seems to me to afford matter for grave consideration in relation to its future government. To diminish the drain now caused by the large force employed in Hindustan, and to reduce the expenditure necessitated by the frequent relief of troops, are subjects which are hourly forcing themselves more strongly upon public attention. Among the means calculated to effect these objects I believe to be the establishment of Military Colonies in the Himalayas somewhat similar to those of Austria and Russia, of which I must content myself with the mere mention, as time will not permit me to dwell upon them.

I feel that I have given you a very imperfect account of what I intended to lay before you to-day. The fact is the subject is so extended that you must attribute the shortcomings of this sketch, more to the unmanageable extent of the subject, than to any unwillingness on the part of the lecturer, to place the matter fully before you to the best of his ability.

There is one little circumstance however that I wish particularly to

mention if you will bear with me for a moment. My friend General Eyre took away five minutes of my time, and I think therefore that I may be permitted to trespass a few minutes longer on your attention. I am strongly of opinion that too low a view has been taken of the influences which affect the health of the soldier in India—that too much has been attributed to climate and soil, and too little to the moral influences which surround the soldier in that country.

You have all doubtless heard that Calcutta is a terrible place to live in. People who have sent their children there, often think that they have taken a permanent leave of them. Many years ago when a boy was sent to India his friends believed, and probably hoped, that they had done with him for many years, perhaps would never see him again; or, if he ever turned up again, it would be as an old man with a full pocket and a yellow skin. Everybody remembers in the admirable biography of Clive by Lord Macaulay the astonishment of the father of the boy at the wonderful hero he had turned out, who was considered anything but a hero when he went away. Now, among the influences that affect a residence in India I believe that climate operates to a very considerable extent below what has usually been attributed to it, and I will tell you why I think so. In the course of last year, a report was published by Mr. Strachey, purporting to show the dreadful condition of European prisoners in Calcutta, and how every possible disadvantage in regard to their health was accumulated in the place in which they were confined. The statement, so far as the buildings and absence of proper sanitary arrangements was concerned, was absolutely correct; but the inference drawn therefrom was utterly incorrect. The Calcutta Jail was assumed to be a Golgotha which killed the majority of those confined in it. When the prison was placed under my charge, I examined its records most carefully, and had its medical returns scrutinized with the utmost diligence and attention. The result, I confess, surprised me not a little. I found that the most depraved, dissipated, and vicious of the European population of the Metropolis of British India—men who recklessly exposed themselves to every possible cause of disease, as soon as they were removed from their evil courses, and placed in a condition of enforced regularity, albeit in buildings of most unpromising sanitary character, instead of dying in crowds, became, in many instances, healthy and vigorous, and that the death rate of the prison in question had never been above the ante-Crimean rate of Her Majesty's Guards in London, even in seasons of the worst epidemic character.

A fair inference from this fact is that, however much sanitary reformers may guard against climatic influences, and improve the physical condition of the soldier,—equal, if not greater attention is needed to his moral welfare. In this all important matter it is that the good influences of the officers of the army are required, and in which their constant care and attention may be most beneficially exercised. We all know that good officers, and particularly a good commanding officer, since on him most depends, make a good regiment—for to be a thoroughly efficient soldier needs, more than is commonly supposed, to

be a good man. Blackguards may, and do often fight well enough, as the history of filibusters and freebooters proves; but a thoroughly good army must be a well-behaved, sober, and well-disciplined army, patient under all trials, and as conspicuous for good conduct in cantonments, as it is for valour in the field.

The discipline of an army depends chiefly upon the care and attention bestowed upon the men by their officers. This is a point on which I am unwilling to obtrude upon you my own opinions, lest upon the *ne sutor supra crepidam* principle, you might fairly say, that as I do not belong to the purely fighting branch of the military machine, and the maintenance of discipline is no part of the special work of a medical officer, his opinions upon the subject cannot be worth having. Most of you are doubtless better acquainted with military history than I am, and are therefore familiar with the views of all great commanders on the point of discipline. No man, I believe, ever has or can be a great Commander, unless he is a strict disciplinarian.

As regards the soldier in India, I can adduce the testimony of two of the most distinguished men who have belonged to the Indian army in our time. In the second volume of the "Calcutta Review," in an article on the Military Defence of our Empire in the East, the joint production of Sir Henry Lawrence and Mr. Kaye, the eloquent and eminent Historian, both of them officers of the Bengal Artillery, this question is admirably treated.

It is clearly shown that it is not possible to exaggerate the influence for good in the power of officers in dealing with and caring for their men. Paradoxical as it may appear, even so great an authority as the First Napoleon, in his military maxims has declared emphatically that valour is not the first quality of a soldier. And assuredly it is not courage of the highest order that has ever been found wanting in the British officer. Wherever danger is, there he is to be found, ever in the front. He is never known, when it is his duty to lead, to follow: his cry is follow me to do this—never go there to do that, of which he does not himself bear the brunt. It is but the other day, when a most distinguished regiment met with a temporary check in New Zealand, that the noble qualities of its officers were conspicuous in the highest degree. In a letter written to me by an eyewitness of the fact, it was stated that, in the belief of the writer, no where in the undying records of human valour is there to be found a higher example of heroic bravery than was shown by the officers in question when they stood alone to face the storm, scorning to yield an inch of ground to the foe. What said their noble hearted Commander after a night passed in unutterable anguish from a mortal hurt, and amid threats of a cruel death from the barbarians by whom he was surrounded—what said he, unmindful of his own suffering when he saw his Commander on the following morning?—"General! I am ashamed to face you, for I have failed to do your bidding."

This is the stuff of which British officers are made—there is no fear, then, that the valour of leaders will ever be found wanting in them. But I concur with Sir Henry Lawrence in considering the duties of the Garrison to be of no less importance, although less showy

and exciting than those of the field, and that in them the officer will find the means of dispelling the *causes* of the climate, and of contributing his full share to the happiness, and consequently to the contentment, and freedom from vice and its attendant train of ills, of the BRITISH SOLDIER IN INDIA.

The CHAIRMAN: I am sure none of you will regret the extra few minutes which our lecturer has taken. In fact the only thing to be regretted is that his time has been so limited, for it is evident that Dr. Mouat contains in his well informed mind the matter of a whole course of lectures. I am happy to be able to suggest that an opportunity, perhaps will be given to us of hearing him still further expound his ideas on this subject. As Captain Scott, who was to have delivered a lecture here next Friday is unable to do so, I only hope that Dr. Mouat may be persuaded to take advantage of that opportunity and supplement the present lecture with what remains to be said, especially on the subject of military colonization, which I believe will be found no less interesting than the lecture which we have heard, and, perhaps, even more important. By the aid of the British soldier we conquered India, and by the aid of the British soldier we must keep it; and whatever contributes to render India attractive to our soldier is of quite as much importance as to keep up our superiority in scientific matters, and in the material of war, for it is only by the aid of our soldiers that, however great our superiority in other respects, we can render it available and of advantage to the State; and therefore I hope Dr. Mouat will kindly yield to the proposition I have made.

Dr. MOUAT: I am sure after the very kind reception you have given me to-day it would ill become me to refuse to comply with your request in any way. I consider this a very valuable Institution, deserving the support of every one connected with the army; and, therefore, so far as my humble services are concerned, I shall be most happy to contribute to its usefulness, by a compliance with your request.

LECTURE.

Friday, May 11th, 1866.

GENERAL SIR W. CODRINGTON, G.C.B., in the Chair.

THE BRITISH SOLDIER IN INDIA—THE MILITARY COLONIZATION OF THE HIMALAYAS.

PART II.

Dr. MOUAT: Sir William Codrington, Ladies and Gentlemen: Those who did me the honour of attending on the last occasion will remember that I endeavoured, but I am afraid very imperfectly, to show the vast extent of territory which has to be occupied and guarded by the British soldier; the large number of influences to which he is exposed in the performance of that duty; how difficult it is, in speaking of India, either in relation to the soldier, or, in relation to any other subject connected with it, to condense the vast amount of information necessary to its understanding within a reasonable compass. Even the subjects of soil and climate, differences of temperature, and more physical differences, are so numerous, that a large number of lectures might be expended in the elucidation of that enquiry alone. I also told you that the very gloomy picture of the condition of the soldier in that country, and the large amount of sickness and mortality to which he was subjected, as pointed out in the report of the Royal Commission, that was first presided over by the late lamented Lord Herbert, and ultimately by Lord Stanley, was rapidly becoming a matter of history, even at the time the Report was written; and, now, has happily become very nearly a thing of the past. A large sum of money has been devoted, and will be devoted, to the purposes of buildings intended to improve the health of the soldier. But I think it only fair, as I told you on Friday last, to state that all the improvements that were suggested in that, or in any other report, for the purpose of ameliorating the sanitary condition of the soldier, have been represented times out of count

during the last thirty or forty years, by the various medical officers who have been in a position to tender advice to the Government on such matters.

Before entirely quitting that branch of the subject, I consider it necessary to notice, especially, one other portion of this report of the Bengal Sanitary Commission, which has been printed by the House of Commons, and which may be, most likely will be referred to, in the course of the present Session of Parliament. It is a very able report, drawn up with remarkable ability, such as might be expected from the high position and the great gifts of the President of that Commission. At the same time, it is particularly satisfactory to me, as a member of the medical profession, to know that there is not one single recommendation, from first to last, contained in that Report that has not been, in some form or other, frequently urged by my professional brethren, proving that there has been no failure of duty on their part. The particular matter to which I wish to refer, now, is one of considerable importance; namely, the ravages of cholera in connection with the European soldier in India. It is shown here, in a manner that is very startling, that the mortality from that fearful disease has been increasing very considerably during the last few years; and has now attained proportions that are alarming. It appears that in the Bengal Presidency alone, since 1854, the percentage of deaths to treated for cholera, among the European troops, has advanced from 50 to no less, in 1863, than 75 per cent. It was reduced in 1864 to 72 per cent. The President of the Sanitary Commission who was also previously President of a special Cholera Commission, states that in his opinion a large amount of this mortality is due, either to positive mismanagement, or to the neglect of precautions which it was easy to adopt. He also surmises that some portion of it may be due to an actual increase in the intensity and severity of the disease.

Now, so far as my experience of it goes—(and very few men, I believe, have seen more of cholera than I have either in Europe or in Asia, for I have been familiar with that terrible disease since 1832, and during twenty-five years of residence in Calcutta chiefly among the European population and the sailors in the port of Calcutta, averaging 18,000 men a year)—I have not the least hesitation in stating, that to the best of my judgment, there has been no increase, whatever, in the severity of the disease, from the first day I witnessed it in Calcutta in 1840, to the day on which I left Calcutta last year. It is necessary, therefore, to look to some other cause for the purpose of ascertaining the real reason of this fearful increase of mortality. Mismanagement is a very general term. I would rather not enter into the question of what specific meaning is to be attached to it in the present instance—whether to neglect or to malpraxis on the part of those concerned in the treatment of the disease—but to show you that the supposed increased intensity of this disease is by no means a fact, I have merely to refer to the mortality of the same years, from the same epidemic outbreaks in civil hospitals among the native population, and in the native army.

We all know, yet perhaps you do not all know so well as I do, what a miserable, wretched class are the prisoners who are confined in the gaols of the Lower Provinces. They are among the most corrupt and depraved of the community. Many of them are in extremely bad health when imprisoned, the consequence of their own vices; yet among these people the mortality has not exceeded 37 per cent.*—a rate of mortality barely half that among the European soldiery, who are well fed, well clothed, protected, in some measure, from vicious habits, and who might be expected, therefore, to fall less readily victims to this disease than the miserable outcasts from society closely packed in overcrowded gaols. Among the native troops who are born in the climate, you would naturally expect a smaller mortality; yet among them it has never advanced to a higher figure than 57 per cent. This is a matter worthy of the most strict and serious consideration. I hold that if you eliminate cholera from among the causes of the high mortality of Europeans in India, you at once change the condition of risk of the soldier, particularly, in some parts of the country, so as to place him not very much below the standard of health that is enjoyed in ordinary service in a more healthy country. In fact in twelve stations in Bengal the death rate is below 10 per thousand already.

I do not, however, mean you to understand that the mere physical or climatic causes of disease are to be underrated or overlooked. At the same time, I think the error in the opposite direction, of looking chiefly to physical causes, as accounting for the deterioration of health, is equally unsound and equally incorrect. You may drain, you may ventilate, you may give ample space, you may provide pure water and abundantly varied food, and so on; but you will by no means have

* My knowledge of cholera since 1855 extends to all parts of the Lower Provinces of the Bengal Presidency.—Dr. Morehead, of Bombay, the author of the best existing work on Tropical Diseases, and an officer of extended experience in Western India, concurs in the views mentioned above; and such I infer to be the opinion of Dr. Edward Goodeve, my successor in the Chair of Medicine in Calcutta, in his recent admirable monograph on Cholera in Reynolds's System of Medicine.

Dr. John Macpherson, an officer of ability and of large experience in India, has more recently published opinions to the same effect.

Every one of the many epidemics of cholera that I have witnessed had some peculiar characteristic of its own, and some varied remarkably in intensity from others; but, as a rule, my impression is, that, except in particularly unhealthy localities, such as Purneah and Burrisal, the average intensity of the disease had rather diminished than increased.

The following numbers afford much ground for reflection and indicate the urgent necessity for careful inquiry by competent professional men, for the opinions of the most gifted men beyond the pale of the medical profession, are of no authority or value in such a question.

The percentage of deaths to treated among the classes mentioned, in Bengal, was as follows:—

	European Troops.	Native Troops.	Prisoners.
1862	61.3	50.3	36.4
1863	75.1	57.0	36.5
1864	72.9	44.0	36.6

These numbers tell their own tale.—F. J. M.

removed the soldier from a very large number of causes of deterioration to which he is liable, and which are more destructive in a tropical than in a temperate climate, unless you operate upon him by moral means and moral agencies. Improve him in education; above all, make him more sober and less reckless than he usually is; and give him such an amount of occupation or amusement as will keep him out of temptation; for, depend upon it, a large proportion of disease in India is due to idleness, and the vices to which idleness leads—and there is no form of idleness more hurtful than that of life in a barrack in hot weather, where the soldier has nothing to do but to lie on his cot, eat, drink, smoke and sleep all day long, and sally forth at sunset to indulge in destructive dissipation. If physical agencies were the chief and greatest enemies to be encountered, all that we should require in the way of sanitary agents of reformation would be a broom and a pail of white-wash, or a carpenter with a foot rule to measure space, or a "navvy" with a spade to regulate drainage. And here I at once fall upon a fact which shows how difficult it is to discuss these questions without local knowledge. It has been stated that the want of subsoil drainage is at the bottom of a very large amount of mischief. Now, I ask any man acquainted with engineering in any form, how you are to drain by artificial means, vast tracts of level country in which if you poke a stick into the ground for six months in the year, not half a dozen inches below the surface, you constantly meet with water. What will become of your subsoil drainage during the six months when the whole country is flooded with the rains. It is not, however, at that time that the most destructive diseases occur; it is when the mass of that moisture is undergoing slow evaporation from the surface, during the gradual subsidence of the floods. Nor is the remedy feasible on the large scale that would be necessary for sanitary purposes, from the enormous cost of draining any great extent of low, marshy country by the least expensive means available. For instance, in the case of Calcutta, about which so much has been said and written, a scientific system of drainage is now being carried out at a great expenditure of money, and there is some reason to fear that it will fail from causes easy to understand. Should it unfortunately miscarry, it will cause more mischief in the way of disease than it is capable, if successful, of removing.

To come, however, without further preface to the special object of my lecture to-day—it being necessary in a discussion of so wide a range to limit the portion that can be considered in a single hour—given the great and gradually increasing difficulty and cost of maintaining the large European force required for India, how can the drain and strain upon the resources of Great Britain be best diminished by simple and practicable means?

There is at the present moment a very large amount of valuable life that is not only not turned to good account, but actually wasted in a most distressing way. I have already mentioned to you the enormous number of casualties among the children of the European soldiers, amounting to 90 per thousand; and the large number of

deaths among the wives of the same class, amounting to no less than 45 or 46 per thousand of women in the prime of life. This is a terrible mortality. And when we reflect upon the fact, that it is quite capable of being mitigated or diminished, until it shall not exceed the loss among the same class at home, I think it is incumbent on us, on every ground of policy, expediency, and humanity if we can show the means of remedying such a lamentable evil, to do so.

Fortunately, for us, there is scarcely a single part of the whole vast continent of India in which there are not mountain ranges, springing from the plains to heights which possess climates in which the European can live and thrive as well as he can possibly do in his own country; or in our more healthy colonies of New Zealand, Australia, or Canada. I believe there can be no doubt whatever upon this point. Mr. Brian Hodgson, a distinguished member of the Bengal Civil Service, who spent thirty years of his life in the Himalayas, and who traversed almost every portion that was accessible in his time, has placed his views on this point on record. He wrote a special paper on the subject, in 1856, to show that, in his belief, this range of mountains affords climates and soils that are perfectly and admirably suited to the European constitution in every respect. There is present in this room another officer of great acquirements, who spent an equal portion of his life in that part of the world—Dr. Campbell, of Danjeeling, who is of the same opinion. Again, all those who have brought scientific knowledge of the highest order to bear upon the examination of the mountains of Hindustan, Drs. Hooker and Thomson, the late Wm. Griffith, and several others who have written regarding it, all tend to a belief in the same direction, viz., that they are in every way adapted for habitation by Europeans. Upon the strength of the unimpeachable evidence recorded by such skilled witnesses I am justified in assuming then, that these mountains are perfectly capable of being inhabited by the natives of Great Britain.

The next question with regard to the founding of colonies or permanent settlements in these hills, especially for a practical nation such as we hold ourselves to be, is, that they should pay, and possess within themselves the means of self-support. For, to be a constant source of expense, or of unprofitable outlay, would absolutely unfit them for the purposes of colonisation. This, I think, although it has not been subject to the same amount of rigid demonstration as climatic influences, is equally susceptible of proof. We have only to examine the soil and see what it is capable of producing, to know that there is scarcely a variety of the cereals, the grains which form the food of man, that is not capable of being produced, and grown in any quantity, according to the area of cultivation, among those hills. In the next place, European fruits and vegetables with very few exceptions, and those exceptions only in particular places, where there is too large an amount of moisture to permit some of them to ripen, all come to maturity in profusion and perfection. You have, then, almost all the vegetable productions of temperate countries, and those of the tropics can be grown in the valleys, or be obtained from the plains in sufficient abundance and at no great cost to maintain European communities living in the hills.

So much then for those productions of the vegetable kingdom which are used as food by man. In addition to them articles of great commercial value can be grown, such as tea, which is already cultivated to a very large and remunerative extent, and the Cinchona plant which thrives admirably, and will hereafter become one of the most valuable productions of the Himalayas. With regard to the animal kingdom, we should not expect an English colony to thrive in any country where they could not get beef and mutton, and a sufficient supply of the animal food to which they are accustomed. There is no doubt that herds and flocks may be reared in different parts of those mountains, differing in quality as regards their fleece and flesh, but practically unlimited in quantity. Pigs and goats flourish and thrive—so does poultry with proper care and management. In addition to feeding the Colonists, a thriving trade might be established in wool, teas, hides, horns, &c. This being the fact, then, and the animal and vegetable kingdoms supplying all that is necessary for the maintenance of a community, I do not think it necessary, even if time permitted of my doing so, to enter further into details to prove that the colonisation of the Himalayas is practicable, if carried out with judgment, and the means and appliances necessary.

Mr. Hodgson, when he wrote on the subject, had in his mind colonists such as now emigrate to America and Australia, and I am told that a Mr. Hyde Clarke, whose pamphlet I have not seen, has written on the same subject, with reference to the extension of railways in India with a view to prove that the Himalayas afforded an eligible field for the emigration of the agricultural and other classes who now seek homes in the New World or at the antipodes. I will attempt to show you, that the colonisation of the Himalayas by time-expired soldiers is still more practicable, and that, in existing circumstances it is a measure of economy as well as of sound policy. Not that I should select a soldier as affording the best material for a colonist,—but having the soldier in India already, great expense having been incurred in taking him there, and further cost being needed to bring him back to where he is not required,—why not turn him to the best account in India, and encourage him to settle there?

The great want of the Himalayas is labour—for without it fields cannot be cultivated, forests cleared, or flocks and herds be raised.—The indigenous population of the hills is very sparse, and they are too lazy and capricious to labour continuously.—Their work is consequently costly, and emphatically bad, and it can never be relied on.—Here then is a wide and profitable field for the utilization of the soldier, when his time of service has expired, and he is anxious to convert his sword into a pruning hook—in fact, to return to civil life again. The old form of enlistment for life was a piece of barbarism that has disappeared with the progress of civilization, and could not again be reverted to, even if it were desirable in itself. Short terms of enlistment are then a necessity of the times, and are among the causes of the greatly increased cost of the army.—The free labour market now comes into very injurious competition with the supply of soldiers and sailors—for like everything else, it is controlled and must be regulated

by the ordinary laws of supply and demand. A cheap army in a time of unexampled prosperity, when every branch of human labour is rising in value, is an impossibility. Like cheap and unskilled labour elsewhere, the worst and not the best variety would be procurable at the lowest market rates; and I hold that nothing short of the best men who can be induced to serve will be really useful, or fitted to fulfil the purposes of an army in a country which is to be held by the prowess and discipline of that army.

Having then obtained the best material at a high cost, and expended much money in "a perfection as a military machine, by the short term of enlistment every soldier discharged at the end of his ten years is a loss to the State at the very time that he is most valuable. It has cost £500 to maintain and make him what he is, and it will take an equal sum to place him, should he be unwilling to re-enlist. There can be no compulsion in this matter—so it seems to me that the next best thing to do, is to render the loss as light as possible—and this I am of opinion can, in no way be so well accomplished as to hold out to him sufficient inducement to settle in the Himalayas,—there to found a new home, and to rear a healthy and happy progeny. The wives and children who perish in the plains, would live and thrive in the hills.

Upon this point I would rather quote the opinions of soldiers, than impress my own views upon you—for none but those intimately acquainted with the soldiery possess a knowledge of their proclivities, such as to render their opinions valuable. Sir Henry Lawrence was probably one of the best soldiers, and certainly one of the best men whom England, in a time when good soldiers and good men have been neither few nor far between—has produced. He has left his mark upon the history of the country in which he spent his life, and he illustrated his blameless life by his heroic death, exhibiting the extent to which the great principle of duty actuated him from first to last. For is there not a record on his tomb that is as great in its way, and will live as long as Nelson's signal that "England expects every man to do his duty?"—is there not, I say, on Henry Lawrence's tomb the simple inscription dictated by himself—"Here lies Henry Lawrence, who endeavoured to do his duty."

This great soldier, whom I hold to have been better acquainted with India than any man of his time, who had studied it thoroughly, and who was equally well acquainted with the British soldier in that country, strongly advocated the grant of lands in the Himalayas to the soldiers, as the best means of diminishing the mortality among themselves, and more especially the greater mortality among their wives and children—and of thus rendering them happy and contented. He held, in addition, that a large body of trained and disciplined Europeans permanently settled in the hills would form a valuable reserve always at hand, and would materially strengthen the army in the plains, should it ever be required to repel invasion from without.

General Eyre, who presided at the last meeting, who is again present, and who was the first officer who brought victory to our

standards, and turned the tide of the Sepoy revolt, has also strongly advocated the military colonization of the Himalayas. Other Indian officers of ability and experience, who have written on the subject have urged the same measure.—I think, then, that I am not wrong in taking it for granted that the employment of English soldiers in the manner indicated has the sanction of some of the most experienced soldiers who have thought and written on the subject.

An appeal to history to learn what other nations have established military colonies, will afford us examples that we may follow with profit, although, perhaps, not without considerable modifications, because the despotic rule of those countries differs so essentially from the freedom of England, that the *modus operandi* of the one could in no way be applied to the other.

Most of you are, I dare say, aware that Austria long since placed what are called "Confins Militaires," or Frontier Regiments along the borders of that portion of her territory, which was in contact with the dominions of Turkey. They formed military colonies, chiefly intended for defensive purposes,—but always liable to be called into active services, and appear to be among the forces now embodied for the great struggle that is supposed to be at hand. Their organization is too strictly military, and they form a Military Caste governed by stringent regulations that could never be applied to colonies of English soldiers in the Himalayas, or anywhere else.

The Emperor Alexander of Russia in the course of the great war with France, visited the Austrian military frontier settlements, and resolved to establish a similar institution in his own Empire. His object was partly to people and bring into high cultivation parts of his dominions in which neither abounded; but this end was subsidiary to the creation of a Military Caste, which should to a great extent be self supporting; should form a valuable reserve from which he could at all times recruit his army, in case of need, with healthy, well trained troops of all arms; which should protect his frontiers from attack; should render secure all additions made to Russian territory; and should ultimately when fully expanded, render conscription unnecessary by furnishing more soldiers than would ever need to be embodied, even in that military and aggressive Empire.—Soldiers of all arms were accordingly quartered in considerable bodies upon the serfs of the imperial domains, and a complicated military organization was devised for the conduct of the scheme.—At first it seems to have been equally unpopular with soldiery and peasantry, and in many instances was violently resisted by the latter. The measure was, however, persevered in without heed to resistance; defects were corrected as practical experience was gained; and so large an amount of success was ultimately attained, that the Emperor Nicholas revisited the Colonies in 1837, and, exhibited to a great concourse of military spectators of all nations, a remarkably fine body of admirably trained soldiers, born, bred, and drilled in his colonies.—Marshal Marmont speaks highly of them in his Travels in Russia, and experienced observers from different countries mention them as decidedly successful.

How they have fared since the emancipation of the serfs I have no

means of knowing, nor is there any information extant to which I have access to show how these Military Colonies met the strain of the Crimean War, in which such prodigious losses were sustained by Russia.—The system on which they were based is of necessity altogether inapplicable to any body of English Colonists, but many of the details of arrangement were excellent, and would bear transplantation with advantage. It seems to me, therefore, to be very desirable that exact information regarding them should be obtained by the deputation of trustworthy eye-witnesses.

The most simple and sensible plan, and the one most likely to succeed in the Himalayas would probably be that of the French in Algeria. In February 1847 an ordonnance was promulgated to establish Agricultural Camps, in which lands were to be granted on certain conditions to soldiers who had served, or were then serving in Algeria.—The time passed in these Camps by officers, non-commissioned officers, and privates was to count as active service entitling to pension on retirement for five years—by which time it was hoped that the settlements would prove self-supporting. A grant of three millions of francs was sanctioned for their establishment, and the greatest care was to be exercised in the selection of the Colonists, all of whom were to marry, if not provided already with wives, as a condition of their selection.—This scheme of civil colonization by the employment of the army was much discussed in France at the time, chiefly with reference to the question of acclimation. The probability is that the experiment failed, because it is now generally acknowledged that Europeans *par sang* can never become thoroughly acclimated in tropical plains, and all the settlements proposed were in the plains. As a mission has recently been dispatched to Algeria, authentic information on this point has doubtless been obtained.

Among all the plans above mentioned, I can imagine no great difficulty in selecting the parts best suited for trial with British soldiers in the Himalayas. It would not, of necessity, answer to attempt the establishment of a Military Caste, or to fetter the freedom of the colonist by any injurious restrictions either as respects himself or the disposal of his children. The compulsory choice of a profession is inconsistent with our ideas of liberty, yet in the case of the father a grant of land might be associated with a certain amount of military service, and from the healthy progeny that ought to be reared in the mountain ranges of India, a fair proportion of candidates for a short term of soldiering would in all likelihood be obtained.

Is it likely, then, that the children of English soldiers, born, bred, and educated in the Himalayas, would degenerate, and form a less manly population than their progenitors? It is impossible at the present time to adduce positive proof on this point, inasmuch as the experiment has not yet been tried. I believe myself that there would be no physical degeneration. All the geographical conditions necessary for the propagation of a hardy race exist in those mountains. Thews and sinews are not wanting in the native races. India contains no more warlike people than the Gorkhas, and a multitude of the fierce fanatical tribes who are a perpetual thorn in the side of the

Punjab government.—Natives of the plains, even the effeminate Bengales, become robust and healthy when acclimated in the hills referred to. Nature having fulfilled her part of producing a healthy and vigorous population, the rest may safely be left to moral influences, to education and association. We hear of no degeneration of the immigrant population of Canada and New Zealand, and the lineal descendants of the Pilgrim Fathers play no unimportant part in the present history of their country.

To discuss further the formation of the character of the descendants of Englishmen in the mountain ranges of Hindustan would open up the whole question of the history of civilization, and render it necessary to show the influence of their institutions upon the moral development of a nation; how far these are affected by climate, soil, food, industrial occupations and the thousand other circumstances that mould a nation; and how far the institutions themselves re-act upon the physical conditions in which a people are placed.—Give them a good education, surround them by the influences which their parents have brought from their own homes, and the free air of the mountains will do the rest. One of the Himalayan settlements, Darjeeling, already contains a third generation of pure blood, and there is no appearance of falling off, so far as I know, in them. On the other hand, there exists no example of a third generation of Europeans of unmixed parentage in the plains of Hindustan.

Thus, again, the question of the acclimation of Europeans in tropical countries crops up. I have already mentioned, the very limited extent to which I consider it possible in the plains. It divides itself into two distinct stages. For the first we have no scientific equivalent to the term *acclimatement* used by the French, which may however be freely rendered into English by the word "seasoning."

When an inhabitant of a cold country proceeds to the tropics it is necessary for him to abandon some of his old habits, to avoid exposure to the sun with an uncovered head, to make such changes in his dress as may enable him to bear a high temperature without exhaustion, and to change his dietary to the extent required by the new conditions to which he is subjected. By this means he gradually becomes seasoned, or capable of resisting climatic influences with an amount of impunity that is denied to the new comer. This is seen every day and nearly every hour in India. The last example that I am acquainted with is contained in this report of Mr. Strachey.

The mortality at Lucknow was higher in 1864 than at any other Bengal station, having amounted to 44.5 per 1,000, of which 15.8 was caused by cholera.—The garrison consisted of the 107th and 36th Foot, the 5th Lancers, and a battery of artillery. The 107th was an old regiment, originally in the Company's service, and which has never left the country since it was embodied. Its loss, and that of the artillery which had also been some time in the country, was comparatively small. The great loss was in the unseasoned regiments, the 36th and 5th Lancers. All the troops in the garrison were exposed to the same influences, and were equally well off as regards quarters, food, &c. The only condition of absolute difference between them was

the more recent arrival of the two regiments in which the great loss occurred—showing that seasoning is of some consequence in such matters.

It is sometimes argued, and I see the argument reproduced in the parliamentary discussions on the subject of the soldier, that long residence in India causes him to degenerate, and that he needs frequent removal and renewal to prevent his losing some of his fine military qualities. Likewise, that continued service in India causes increased sickness and mortality.—I do not believe either of these views to be correct, and the extent to which they are true is not only very limited, but perfectly susceptible of explanation. Numbers, so far as the statistics of sickness and mortality are concerned, may be manipulated without any intention to deceive, be made to prove anything. Monsieur Quetelet has shown that 35 years is the age in Europe of what is termed the greatest viability, or in which the value of life is highest, and that after this age the chances of death increase as life advances. To this extent India obeys the general law, but I am not aware that it increases the risk of the seasoned, after 35, to such extent as to form a special law of mortality for that country. The contrary is the result of my personal experience of a quarter of a century. That the old seasoned soldier in India is a less valuable fighting animal than the new comer is entirely disproved by past experience in that country both among Royals and the late Company's European forces. King's and Queen's regiments formerly remained so long unrelieved, that few of those who went out in them lived to return. The Company's regiments spent the whole of their military lives in India, the survivors returning to Europe only when unfit for further service from age or infirmity.

Ever since the first Afghan war there had been constant fighting in India, on a scale never before witnessed, and consequently constant opportunity of testing the fighting qualities of the European soldiery. With what result? So far as I know, or have ever heard, no royal regiments were ever in better fighting trim than at the conclusion of their Indian career, when climate had done its worst upon them.*

* A multitude of examples of this might be given. Among those known to me were the 16th Lancers and 3rd Light Dragoons in the first Sikh war; the 10th, 20th, 50th, 80th, and many other infantry regiments in the same campaign; all the old regiments engaged in the suppression of the Sepoy mutiny, for Delhi was taken before a single fresh soldier arrived in India. Lucknow was defended by seasoned troops until relieved by Havelock and Outram; and Great-bred's column consisted of a portion of the Delhi field force. Of the Delhi force itself, all the corps being equally exposed, and having equal shares of fighting, the Company's European regiments, bore the strain of war with least loss and suffering. If the records of the Indian army for the last half century were carefully scrutinized I am quite certain that the same result would be found to be constant and invariable. Since this was written I have been told by one of the distinguished officers alive at the present time, that he saw the 1st Bengal Europeans and the King's 76th Foot, a famous regiment in those days, go into action together at Deig, some sixty years ago, and that for brilliant fighting, it was impossible to perceive any difference between them. The first named corps was then nearly fifty years old, and had passed the whole of its life in India; the 76th had only been a short time in that country.—F. J. M.

The illustration afforded by the Company's Europeans is still more convincing, for up to the present moment, with the exception of a brigade of Horse Artillery, none of them have ever left India since they were originally raised. In the very last campaign, of which little has been said or written, but which was one of the most creditable feats of arms ever performed in India—the Umbela Campaign against the fanatics of the North West Frontier—the brilliant daring and stubborn endurance of the old regiments were objects of general admiration to all who witnessed them. During the Sepoy Mutiny, if I have been rightly informed—and my information came from many of the misguided men themselves when imprisoned—the old were much more feared by the Pandies than the new regiments, although there were among the latter some of the finest corps in the British army. The cause of this was, as I understood, that the old regiments closed more rapidly, and went more thoroughly in at them—some degree of contempt for their old acquaintances being most probably at the bottom of it.—Be that as it may, the Sepoys never stood long against the cheer and the rush in the open plain. A story was current at the time, which illustrates my argument. An old Soubudhar covered with medals, some of which dated back from the days of Lake, Deig, and the Delhi of the beginning of the present century, was asked why he and his brethren who always fought well under the guidance of their European officers, behaved so ill, and made so little stand in the Mutiny. His reply was: "It is quite true, Sahib, our hearts are valiant, and our courage as great as ever—but the moment we heard the British shout, and saw the Europeans closing on us, our rascally legs carried us in the other direction, and overpowered our hearts." It was the cheer and the rush that did the work.

Has the world ever seen a finer body than the old Company's artillery of the three Presidencies? Their greatest eulogists have been their most eminent commanders—whose prejudices and predilections, if they had any, for they are Royal officers to whom I refer—would have been in the opposite direction. Sir Charles Napier after an unrivalled experience in war, pronounced the Indian Artillery as being perfect from fifteen years of constant campaigning. In the Mutiny, when the Royal and Company's gunners were for the first time associated in the field, not only was no inferiority detected in the latter, but they were regarded with admiration by their brethren of the same arm fresh from Woolwich, and were highly prized for their efficiency and their rough and ready qualities by their Commander the late Lord Clyde. Finer artillery, in fact, did not exist. Remember then that the men of the old Indian artillery had spent the whole of their lives in the plains of Hindustan, for there is no artillery station in the hills; many of the older men among them had been fifteen or twenty years in the service, and had been exposed to every possible climatic cause of deterioration, without the smallest diminution of their military virtues.

This disposes, I think, effectually of all arguments for rapidity of relief based upon any supposed deterioration from long residence and service in India.

And now to return to our project of colonization, which I am afraid

I am treating somewhat discursively. Seasoning in the plains is a salutary and useful process, but, in them, the second stage of complete acclimatization is for Europeans altogether impossible and impracticable. One of the principal causes of the great amount of cost incurred by the large European force now employed in India, is the supposed necessity for frequent reliefs. I have attempted to show that such reliefs are not a necessity of climate, or of military efficiency—for if, in what are now olden times for India, before the days of railways and hill stations, Europeans had a fair chance of life with ordinary care and attention, and suffered no loss of military prestige and efficiency, still less can they be considered necessities when so much has been done, and with such excellent effect to improving the condition of the soldier. The necessity is undoubted, but is altogether one of the present conditions of service, and a direct result of the abolition of the permanent European force formerly entertained. In fact so far as health is concerned the necessity would disappear entirely, if the bulk of the European Army were cantoned in the hills, and the term of service at unhealthy stations in the plains were limited to short periods. The standard of health of a regiment in the hills ought to be as high as that of the most favoured quarters in Great Britain, and would be so, by proper care and management. The sanitary condition of many of these hill-stations was, until very recently, by no means as good as it might be, were more attention paid to those conditions that would be necessary for the maintenance of health in Paradise itself. For the European army there is an abundance of land available, the climate is as good as their own, probably better—and the most perfect acclimatization is not only possible, but proven.

For the bulk of the European Army then, the question resolves itself into one of the military defence of the Indian Empire, a topic to which I can devote but a few passing remarks:—yet it is one that might be discussed with great interest and advantage in this Institution. The most interesting monograph on the subject that I am acquainted with is that of Sir Henry Lawrence to which I referred in my last lecture. It was written in 1844, long before the establishment of railways, and before the experience of the real source of our weakness in India, as prophesied by Sir Henry, was shown by the Sepoy revolt of 1857. He was of opinion that three-fourths of the European Infantry, and half the Dragoons and Artillery might be placed in the hills.

The doctrine now advocated is that 20 per cent. is the limit, with reference to strategical purposes. I am inclined to rely far more on Sir Henry Lawrence's judgment, which has stood the test of time, and the roughest handling to which the English power has ever been subjected in India, than to that of any other authority with whose opinions I am acquainted. He had studied the question carefully, and possessed a more intimate knowledge of India than any other man of his time.

Irrespective of strategical questions, part of the objection to place the greater part of the European army on the hills, is I believe, one of

expense—the European Soldier at present costing far more in the hills than he does in the plains. This arises from the greatly increased cost of food and necessaries, and from the very expensive establishments now entertained. The former might be diminished by producing the principal articles of consumption, including beer, in the hills themselves,—and the latter might with advantage be dispensed with, even in existing circumstances. When a European regiment ascends the mountains, it takes the whole of its Native Establishment with it, and a very ragged regiment they form of cooks, barbers, washermen, tent-pitchers, *et cetera* of "tag rag and bob tail," as every one familiar with India knows. In a European climate the English soldier ought to be made to perform all those duties which he discharges without question and of necessity at home—instead of being waited upon by a wretched collection of shivering, half clothed natives of India. There would be no difficulty in the matter in the hands of efficient Commanders, as I can show by reading to you the opinion of an officer of great experience, Colonel Robertson of the 6th Foot, which I am able, by the kindness of Dr. Campbell of Darjeeling, to lay before you. The following is an extract from a note written to me by that gentleman: "There is one suggestion connected with cantoning European troops on the hills which I have not seen advocated, but which is worthy of serious consideration. It has reference to the greater expense of maintaining the men in a good climate than in bad ones; an objection which has long told against countervailing advantages. Col. Robertson of H. M. 6th Foot, commanded his regiment at Darjeeling when I was there. He was an experienced and very zealous officer, and was very successful in establishing workshops, and other useful occupations for the men."

"After careful attention to the climate of the hills; and having served in all quarters of the globe, he came to the conclusion that the men could do everything for themselves in the Hills that they do in England; and that the whole array of native camp-followers who cost so much in the plains and are doubly expensive in the Hills, might be dispensed with during the turn of duty of each Regiment there."

"His plan was, that a Regiment occupying a Hill Station for the first time should on arrival there dispense with all its cook-boys, barbers, washermen, water-carriers, scavengers, tent-pitchers, &c., and that the relieving troops from the plains should make over to the returning one the whole of these native followers along with its elephants, camels, and all other means of transport required for marching in the plains."

"Colonel Robertson was by no means a rash man, and no one had the welfare of his men more at heart than he had. He knew what British soldiers could do, and what would suit them; and he would gladly have tried his plan to help in removing objections, on the score of expense, to giving our soldiers the benefits of good climate which are so pertinaciously denied them."

There is no doubt that if this were done two great advantages

would result. In the first place, a larger amount of what is very much wanted in the Hills as well as in the plains—occupation—would be given to the soldier. I have been in Hill stations with the soldiery. There is at present no earthly amusement in those places for them; their duties are very light; they have a parcel of poor native attendants to perform operations for them which they could do much better for themselves, and they are sorely puzzled to devise the means of killing time. Now, by getting rid of so much of the expenditure at present incurred, a very great objection to cantoning large bodies of European Soldiers in the hills would be removed. It would carry with it, the subsidiary but by no means secondary advantage of taking the women and children there.

Some writers of authority in India consider it to be visionary to advocate the wholesale transfer of the children of the English soldiers to the hills on account of its expense, their views being that each child would cost as much as it takes to educate a gentleman's son for a profession at home. The maintenance and education of a boy or girl at the Lawrence Asylum now costs £40 a year, which is a very modest sum to assign for any kind of professional education in England—and this amount is much greater than need be, or would be incurred by the establishment of schools on a more extended scale, and under a different system of management.

If we had large bodies of Europeans quartered in the hills, either in cantonments or colonies, the children ought, in a very few years, to be brought up there at rates little exceeding those of children of the same class in England. Whatever the cost, however, is it not incumbent on a Christian Government which owes so much to its European soldiery, to diminish the distressing mortality among their children, by every means in its power without regard to cost. The expenditure would prove an economy in the end.

In what manner, then, ought military colonies to be established in the hills, so as to ensure all the conditions of success? I have been told that the experiment has already been tried, and that it failed, so that when General Eyre revived the question, at the time that India was transferred directly to the rule of the Crown, it was not deemed advisable to subject it to a further trial. But how was it tried? A few worn-out old pensioners were taken from the the hottest rock in India Chunar, which is at the same time the head-quarters of chronic intoxication, and were sent to Cherra Poonjee, on the eastern range of the Himalayas, the wettest place in the world. It is difficult to give to any one unacquainted with the locality the faintest idea of its characteristics, and of the extreme changes to which the ancient votaries of Bacchus were subjected, without a suspicion of exaggeration. The rain fall at Cherra may be calculated in yards, rather than in inches, for the down pour averages more than 600 inches, or 50 feet of water annually. I once spent three days there in the height of the rains, and they were the most amphibious days of my life. To approach the place we steamed across a lake some forty miles in extent, with the river Soorma winding through it with a tortuosity that would have broken the heart of the river God, Meander. The

villages in this vast liquid plain appeared to be dotted about in a most eccentric fashion, but were in reality placed on the high land forming the banks of the stream, as I found when visiting the place in the dry season, when the water had run off, and the lake was converted into a gigantic rice-field. The steamer passed through the main street of the villages, in some places almost brushing against the roofs of the huts with her paddle-boxes. The inhabitants swarmed on the tops of their houses to stare at us as we passed, the steamer in which I was having been the second that had ever been seen in that part of the world, and the first that had wound its way across the lake in the rains. It is now better known, being the high road—indeed the only road—to the tea gardens of Cachar, then a wilderness, now containing an active, enterprising European population of 3 or 400 persons. We produced a great and unexpected commotion among the dusky damsels who came forth to look at the steamer, by turning our glasses towards them. They shrieked and disappeared very much as frogs dive when a boy throws a stone at them, and on enquiry we found that some Bengali wag had told them, that spy-glasses possessed the property of turning every one upside down towards whom they were turned!

When I reached Cherra, the cause of the flooding of the low country was apparent enough, and realized the classical description of the mountains from which Deucalion looked down upon the floods in the deluge of mythology. In the three days of my stay it rained 23, 24, and 26 inches—each of them more than the annual rainfall of some countries. Indeed, I was even shown a man at Cairo who had come in from some place in the desert, and who, although seventy years of age, had never seen a shower of rain. To ride from one bungalow to another, at Cherra, between the showers, was usually a hot race, for with every precaution in the shape of macintoshes and waterproof boots it was sometimes impossible to escape a thorough drenching, however hard you galloped. The effect was very much as if the Serpentine were taken up into the air, and suddenly upset on the heads of the riders in Rotten Row without warning.

To this station, in which all soil is washed off the rocks, and which is damp in the last degree, the baked old pensioners were suddenly transferred from Chunar, with nothing to do and no one to look after them. The poor old fellows soon began to shiver and shake, they crept into their dens, and to keep out the rheumatics took to strong drinks in a fashion that converted their chronic into acute intoxication, under the influence of which they rapidly disappeared, as might have been expected.

It is not of such material that I wish my military colonists to consist, but of sober, steady, healthy young men, with wives and growing families, men able and willing to cultivate the soil, and to become the pioneers of civilization as their countrymen have been in so many parts of the world, where great and wealthy cities have displaced dark and dismal forests,—and where howling wildernesses have become smiling plains, from the results of human labour.

I believe the picture which I have drawn of the senile settlement of Cherra Poonjee to be by no means over-coloured, although I perceive among my auditors an officer intimately acquainted with the facts of the case, who shakes his head with an air of doubt. In any event, I am sure that he will concur with me in considering that the experiment was not fairly performed; that its failure proves and teaches nothing; and that it might be tried again under such conditions as to give it a fair chance of success.

The soldier who has been cared for all his life, and has never been called upon to exercise the smallest amount of thought regarding his maintenance, or the disposal of his time and talents beyond the pipe-clay cycle of military duty, needs some guidance to start him in life as a colonist. The plan best adapted for that purpose, inasmuch as it would leave him the largest amount of personal liberty, and call for the smallest return in the shape of Military Service, would probably be that of the French in Algeria to which I have already referred.

A couple of officers on the same condition of service as the men were appointed to control and regulate the affairs of each of the Agricultural Camps; the villages were constructed on fixed plans to secure every necessary convenience, as well as to combine economy with efficiency; the implements and other materials for husbandry were provided; and the whole settlement was on regular pay for a period not to exceed five years. If they have failed—and I have no information on the subject—the failure must have been due to climatic causes, and to the camps being placed in the immediate vicinity of hostile Arabs—neither of which conditions would occur in the Himalayas.

My plan then would be this. I would in the first instance select most carefully 300 well conducted, healthy soldiers whose term of service had nearly expired; and I would take equal care that my intended colonists had healthy, well conducted wives, with young families. These 300 families I would form into one village community, with grants of land of sufficient extent to admit of their supporting the village when fully cultivated. To each village I would appoint a Captain and Subaltern, married men with growing families to control and direct it in all matters in which guidance was required. The officers should also have grants of land and become *bona fide* settlers, and they should be armed with all the powers necessary for the entire management of their charges. Medical attendance and education, with which religious offices and instruction should be combined, I would likewise provide—every member of the community having his grant of land and being thoroughly identified with it.

In addition to attaching some light condition of military service to each soldier settler, from each family I would exact the condition suggested by Sir Henry Lawrence of supplying a recruit for service for ten years to the European force in India.

By some such plan as this carefully worked for five years, the practicability of the Military Colonization would be fully tested, at a cost that could be more easily borne by the revenues of India, than

the large outlay now incurred in sending time-expired soldiers to Europe, and removing regiments without any real necessity as frequently as seems to be contemplated, on pleas of health and necessity which are utterly untenable.

The French calculated that £40,000 was sufficient to plant and maintain each of their military camps until they were self-supporting: the same sum would probably be found sufficient in the Himalayas. I would plant three such colonies to test the matter completely—one in the Western Himalayas, a second centrally, in the vicinity of Darjeeling, at about the level of Hope Town or Lebong, and the third in the new settlement of the Eastern Himalayas, to which the station of Cherra Poonjee has been transferred. Officers and men possessing all the necessary qualifications could, I am satisfied, be easily found—and the plan itself would, I am certain, be hailed with satisfaction by the European soldiery in India. It would also, I believe, produce a feeling of contentment that does not now exist, whatever may be the cause.

The old Company's Europeans were emphatically a contented army; the men were attached to the country and did not desire or care to leave it. Their officers were equally well satisfied, and none of the grievances which are now so prevalent were ever heard of. The cause is obvious and on the surface. Men and officers had alike a permanent attachment to the country; it was to their interest to cultivate kindly feelings towards the natives; and all were content to take their Indian service, as they took their wives, for better or for worse, and to make it practically a life engagement.

Such is not the case at present. Every regiment sent to India looks or hopes for a speedy return; regards its Indian service as a disagreeable banishment; and has no thought of taking root in a tropical soil. The soldier at the end of his ten years either pines for home, or leaves the army to better himself, or is unwilling to continue to serve without increased pay and better prospects of advancement. It is true that he can remain in India if he forms local ties, or prefers the country for any other reason by volunteering; but this breaks up his home—he leaves the regiment which was his first love—and has to begin his military life again in a new regiment with no sympathy with him, and which will for very long regard him as an interloper.

No Colonel will, if he can help it, let his best men go, and few good men care to leave a regiment to which they are attached, which is well commanded, and in which they like their officers. As a rule, I have heard it said by those who ought to be well acquainted with the matter, that the worst men are those who most frequently volunteer, and that a regiment can be made too hot to hold those whom every good commanding officer is anxious to get rid of. The result must be that the worst soldiers remain in a country in which the best are needed; and that crime and increased disease and mortality are among the logical consequences of the present system.

It was not so in the old system. The soldier's first regiment was his home which he only left for some staff appointment, or when his time of service was at an end. I am, therefore, strongly of opinion

that the question of a local European army should be revived, and in it I see the solution of much of the present difficulty in recruiting. At all events the present plan has failed; the amalgamation has satisfied no one connected with it, with the probable exception of the few who have personally benefited by it; and the necessity of devising some new method of rendering the army attractive has become a necessity.

Formerly the greatest punishment that could be inflicted on the Company's European soldier was to turn him out of the army and send him home. Now most of the Europeans in India are home sick, and craving to leave the country. Whether this new form of nostalgia is increasing in intensity, and whether much of it may not be due to the now rapid communication with Europe, I am unable to determine. But, I think, that a return to plans which produced contentment for a century, and the departure from which has been followed by chronic discontent, would tend much to mitigate, and might possibly remove the present difficulties. I do not in the remotest sense advocate the revival of the grand old Corporation which is dead and buried, and is rightly a thing of the past. There is I am convinced not a soldier of the old army, who is not proud of being a Queen's soldier, or who would willingly consent to the severance of his direct title to be so considered. At the same time I am satisfied that it would be wise and politic to renew, in an improved form, the old ties to India, and to give to the soldiers the means of becoming settlers, which bind them so strongly to Canada, New Zealand, and other colonies in which they can now have grants of land on favourable terms. In those countries, I believe, they have proved among the best of the colonists, for their military service, and the strict habits of obedience and self-control in which they have been trained, are, if they are only moderately sober, the best preparations for good citizenship in civil life. If, therefore, the incentive to good conduct that would be produced by grants of land in the Himalayas to the well behaved, were held out to the soldiers in India, with the protection that would thereby be afforded to their wives and children, it would certainly make them contented to remain in India; and by establishing military colonies in the Himalayas we should acquire a stronger hold of the country and render more material assistance to England for its retention than by any other arrangement that can be devised.

Beyond the question of the competition of free labour, the increase of emigration, and the rise in wages, with recruiting on the present terms—in which soldiering being the weakest, must go to the wall—there is, I suspect, a good deal of dread of service in India among the classes from which recruits are obtained. It must be remembered that, according to the last returns, there are only 12 per cent. of the men now in the army who are unable to read. All that has been recently written of the great risk to life in India, with the painful pictures of disease and death that have been painted by Royal Commissions, is reproduced in exaggerated forms by the penny press, and penetrates to the remotest villages in the country. Every man who now enlists, unless it be in the Household Regiments, knows that

he must of necessity have his term of Indian service; and an undue dread of India has taken firm root in the public mind.

Might not one or two of the professors of Military History, who are now supposed to be more numerous than is necessary, be profitably employed in dispelling the delusions regarding the risk of an Indian life?

My time is up, and I feel that I have treated this question in a manner quite incommensurate with its importance. I trust, however, that I have succeeded in showing that it is possible to colonize the Himalayas; that their colonization by English soldiers would ultimately be a measure of economy; that it would save a large amount of valuable life, particularly of women and children, that is now needlessly wasted, and the cause of much misery and suffering to those who are unable to protect themselves; that a healthy, vigorous, manly white population may be raised in the mountain ranges of Hindustan, and that such a population would form the best possible barrier against the hordes of Central Asia, and furnish the best means of resisting attack from within or without, in any possible contingency that may arise in that country.

I know of no current question that could be discussed with greater interest and effect than that of the military defence of the Indian Empire. By the very last mail has come the intelligence that Sir William Mansfield, the present gifted Commander-in-Chief in India, recommends the immediate reduction of the European Force in that country by 5,000 men, improved means of communication having multiplied the power of the European army, so as to render a smaller force by concentration and rapidity of movement equal to what required a much larger expenditure of power a short time since. Whether such a reduction be prudent and politic, no man can have better means of knowing than Sir William Mansfield. At the same time it must be admitted, that whatever diminishes sickness and mortality, and keeps the men in vigorous health, multiplies the power of those men to a degree that cannot be fully represented by figures. Such a measure I hold to be the occupation of the Himalayas by the bulk of the European army in India—and the formation of a reserve of incalculable value to future times by the establishment of military colonies in that magnificent range of mountains.

Whatever may be the result of the discussions as to the maintenance of the present system, or the restoration of a local army, I am thoroughly convinced that Her Majesty possesses no more loyal and devoted subjects, his Royal Highness the Commander-in-Chief, no men more contented to serve under him, and England no sons better able or more willing to uphold her honour on all occasions than the British army in India. (Applause.)

The CHAIRMAN: For the kindness of Dr. Mount in giving this lecture, and for the intelligence he has displayed in dealing with the subject, and the information he has communicated, I am sure I may ask for your best thanks. It happened that General Eyre did not arrive in time to take the chair on this occasion; and I do not know whether he wishes to make any remarks. No subject can be more

interesting than the management of our army of 60,000 Europeans in India. Every detail Dr. Mouat has brought forward in a manner to elicit our warmest admiration, and in the name of the members I beg to tender to him our best thanks.

ON

*Proposed by Parker
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CARBOLIC OR PHENIC ACID

AND ITS PROPERTIES.

By DR. F. CRACE CALVERT, F.R.S., &c.

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CARBOLIC OR PHENIC ACID.

The following lecture was delivered in French, a few months since, by Dr. Crace Calvert, F.R.S., F.C.S., &c., before the Society for the Encouragement of National Industry in France:—

GENTLEMEN,—I have readily accepted the friendly invitation of your illustrious president, M. Dumas, to submit to your notice some facts relative to carbolic acid. But before doing so, allow me to express publicly the feelings of gratitude which I owe to France for having opened to me the way to the profession which I pursue with such pleasure. In truth, it is to the sympathy of scientific men of this country, to the friendly assistance of one of your scientific celebrities, M. Chevreul, and to the liberality of your institutions, that I owe the knowledge I have acquired, the elements of which I gained at the Gobelins and at the Museum of Natural History during the stay I made there. After these remarks I will proceed with the subject of my lecture.

No doubt most persons present are aware that when coals are submitted to the action of a dull red heat, in a retort, products are obtained which may be grouped into four classes.

1st. Gaseous products, commonly called coal gas, and which are now employed in so general a manner as means of illumination, sources of heat and motive power.

2nd. Water containing ammonia and ammoniacal salts, substances which chemistry purifies, modifies, and which are then utilised in agriculture, manufactures, and medicine.

3rd. There distils with the above products a black, sticky substance, of an unpleasant odour, called tar.

4th. There remains in the retort a solid, porous body, which is known to us all as coke.

When the above-mentioned product called tar is submitted to distillation, water first comes over, then there distil jointly with this fluid, liquid carbo-retted hydrogens, which, being lighter, float on it, and are therefore called *light oils of tar*; and, lastly, compounds heavier than water are collected, which bear the name of *heavy oils*.

It is these heavy oils which were the first tar products utilised in manufacture. Their consumption made such rapid progress in England, that special manufactories were established for their preparation, and these works were, for a long period, the only ones in which tar products were produced. Most of them were established between 1817 and 47, for the production chiefly of coal naphtha, used for many purposes, and heavy oils, employed for the preservation of railway sleepers, by a process discovered by Mr. John Bethell, by means of which they are preserved twelve or fifteen years; whilst without it they decay after three or four years. I have much pleasure, whilst on this subject, in calling your attention to a very remarkable and very complete work upon the cross-graining of wood, by M. Forster, chief engineer of the department of La Vendée, assisted by M. Marin. These gentlemen have made numerous experiments, the result of which is that wood thus treated is preserved from decay in water as well as under ground, and, what is important, wood is no longer destroyed by that very destructive insect the *teredo*.

Lastly, there remains in the still (after the heavy oils and some semi-solid substances have distilled off) a product, which is fluid at the high temperature at which this operation is conducted, but which, when exposed to the natural temperature of the atmosphere, becomes hard and brittle, and is known under the name of *pitch*. This product, as you are aware, is largely employed in Paris under the name of asphaltic bitumen, &c., to make the foot pavements and public walks, as well as for the manufacture of a sort of concrete, called in England patent fuel.

After this rapid sketch of the products given off during the distillation of coal and tar, allow me to call your attention to *carbolic* or *phenic acid*, also called *carbolic* or *phenic alkali*; in fact the latter is the most appropriate name for this substance, as its properties are not those of an acid, but that of an alcohol.

It is now twenty years since Laurent, the eminent chemist, first pointed out an easy method of extracting carbolic acid from coal tar. It consisted in submitting the light oils to a fractional distillation, and then treating with a concentrated solution of potash those products which had distilled at a temperature between 160° and 200° degrees, separating the alkaline solution from the hydrocarbons which floated on it, and then neutralising the alkali by an acid which liberated the carbolic acid.

Such was Laurent's method of preparing carbolic or phenic acid, but pure carbolic acid was only there in a very small proportion; it was, in fact, a mixture composed chiefly of different liquids similar in properties and composition to carbolic acid, and though Laurent succeeded in obtaining solid carbolic acid, still the process devised by him was too expensive to answer on a manu-

facturing scale; and besides, his method of operating was too complicated.

In 1847, Mansfield, and towards 1856, M. Bobouf, made known processes which, in fact, were only a modification of Laurent's, for they consisted principally in employing caustic soda instead of potash, and in treating the whole of the light oils instead of a special portion of them, as Laurent had done; still, by these processes, a very impure acid was obtained, from which it was very difficult, as experience has shown us, to extract pure carbolic acid; however, in a commercial point of view, the process of these gentlemen was a step in the right direction. This method was followed by Mr. Clifts in manufacturing some carbolic acid for me about the year 1847; and it was this impure acid which was employed by several chemists who, like myself, studied the properties of this substance, and who were endeavouring to apply it usefully; and I succeeded at about that time in applying it to the production of picric acid, or in preventing the transformation of tannic acid into gallic acid, in tanning substances, or, finally, in the preservation of subjects for the dissecting-room. M. Bobouf also made use of it in preserving organic bodies from putrefaction, a property which has received of late very important applications.

In 1859, M. Marnas, of the firm of Guinon, Marnas, and Bonnet, of Lyons, came to Manchester, and asked me to furnish him with a purer carbolic acid than had been as yet manufactured. He showed me a white and crystalline product, which he gave as a specimen. It was then necessary to make new experiments, and we (F. C. Oliver and Co.) discovered that the best mode of preparation was not by treating light or heavy oils of tar with concentrated alkalis, but, on the contrary, by treating the impure benzines of commerce or naphthas with weak alkaline solutions. By this means a semi-fluid, blackish product was obtained, a little heavier than water, of a density of 1.06, and which contained 50 per cent. of real carbolic acid, which acid we managed to separate in part by careful distillation; and it was this product which was employed by Messrs. Guinon, Marnas, and Bonnet, and others, till 1861, for the manufacture of colours derived from carbolic acid. At this period the colours obtained from aniline were so fine and brilliant that, to keep up a comparison with them, it was found necessary to improve those derived from carbolic acid. To effect this it was necessary to improve the quality of the carbolic acid then manufactured, and, after some trials, we produced carbolic acid in white detached crystals, melting at between 25 and 27 degrees, and this is the product which is now generally employed in commerce and industry, as witness the specimens which are to be seen of it at the present Universal Exhibition. In 1863 this relative purity was insufficient, and the same firm which had required the improvements

which I have before named asked us to try and make it still purer. We again set to work, and produced commercially Laurent's phenic alcohol, or carbolic acid; that is to say, a substance melting at 34 degrees centigrade, and boiling exactly at 186 degrees. This became a very important commercial product for us, and we delivered large quantities monthly.

From this time I made many efforts to draw the attention of the medical profession to the really remarkable therapeutic properties of carbolic acid, but the tarry and sulphuretted odour which it still possessed was a serious obstacle to its application. I soon succeeded in overcoming this difficulty, and towards the end of the year 1864 our firm was in a position to deliver in considerable quantities carbolic acid deprived of sulphuretted compounds, and therefore fit for all medicinal uses. But I am glad to say that the series of improvements in the manufacture of pure carbolic acid, or phenic alcohol, did not stop there, for towards the end of last year I discovered a process which now enables me to show you a product completely deprived of all disagreeable odour and tarry flavour, and, in fact, as pure, though extracted from tar, as if it had been produced artificially by the help of the reactions recently discovered by Messrs. Wurtz and Kékulé, based upon the direct transformation of benzine into carbolic acid, or by the well-known changes by which it may be obtained from salicylic acid or nitrobenzene. This new phenic or carbolic acid is distinguished from Laurent's in being soluble in 20 parts of water, whereas the latter requires 33. It is fusible at 41, instead of 34, and boils at 182 degrees, instead of 186, but it gives, like Laurent's, the blue colour described by M. Berthelot when mixed with ammonia, and to the solution is added a small quantity of a hypochlorite; the same effect is also produced when you expose to the vapours of hydrochloric acid a chip of deal soaked in this pure carbolic acid.

It was supposed that, as Laurent's phenic acid had a constant boiling and crystallisation point, it was a pure and definite substance. Now, the production of our new acid shows it is nothing of the kind, the product of Laurent being only a combination of our pure carbolic acid and a liquid homologue; for when to the acid of Laurent is added a certain proportion of water, and the mixture is exposed to a temperature of four degrees centigrade, it deposits a crystalline substance in large octahedrons, which is a hydrate of carbolic or phenic alcohol, that is to say, carbolic acid combined with an equivalent of water of crystallisation. This fact is important in a chemico-theoretical point of view, for it exhibits the only example known of an alcohol which, combining with water, forms a crystallised hydrate. By removing from this hydrate the equivalent of water which it contains, carbolic or phenic acid is obtained in its pure state.

We will now rapidly glance at the applications which have been made of this remarkable substance for sanitary purposes, in medicine, agriculture, and manufactures.

The disinfecting or rather antiseptic properties of carbolic acid are very remarkable. The beautiful researches and discoveries of M. Pasteur* have shown that all fermentation and putrefaction is due to the presence of microscopical vegetables or animals, which, during their vitality, decompose or change the organic substances, so as to produce the effects which we witness, and as carbolic acid exercises a most powerful destructive action upon these microscopic and primitive sources of life, carbolic acid, therefore, is an antiseptic and disinfectant much more active and much more rational than those generally in use.

It is necessary that I should here make a few remarks, explanatory of the distinctions between *deodorizers*, *disinfectants*, and *antiseptics* :—

Deodorizers.—All substances merely acting as such are neither disinfectants nor antiseptics, as they simply remove the noxious gases emitted from organic matters whilst in a state of decay or putrefaction, without having the property of arresting decomposition or fermentation, for it has been proved that the source of infection or contagion is not due to noxious gases or bad smells (being merely indicators of its probable existence), but, as we shall see presently, to microscopic spores floating in the atmosphere, and which by their ulterior development and propagation, are believed to be the true source of contagion.

Disinfectants.—Under this head may be classed bleaching powder or chloride of lime, sulphurous acid and permanganate of potash; they first act as deodorizers, and then as disinfectants, but they must be employed in large quantities to thoroughly oxidise or set upon organic matters, so as to prevent them from again entering into decomposition, but still it is known that if the organic substances so acted upon are exposed to the atmosphere, they will again experience decay and putrefaction; they are, in fact, more destructive agents than disinfectants, and they are never antiseptics.

Antiseptics.—Antiseptics, such as corrosive sublimate, arsenious acids, essential oils, carbolic acid, &c., act as such by destroying all source of decay and decomposition, that is to say, they destroy or prevent the formation of the germs of putrefaction and fermentation, without acting upon the mineral or vegetable matters present. The advantage of their use is, therefore, that they act, when used in small quantities, upon the primary source of all organic matters in a state of decay; further they are deodorizers, for they prevent the formation of offensive

* See "Comptes Rendus de l'Académie des Sciences" for several years past, and my lecture at the Society of Arts, 1863-68.

odours, and consequently they are antiseptics, disinfectants, and deodorizers. The great advantages which carbolic acid possesses over all other antiseptics are, that it cannot be used for any illegal purpose, as arsenic and corrosive sublimate.

And allow me further to add that disinfectants, such as chlorine, permanganate of potash, or Condy-fluid, operate by oxidising not only the gaseous products given off by putrefaction, but all organic matters with which they may come in contact; whilst carbolic acid, on the contrary, merely destroys the causes of putrefaction, without acting on the organic substances. The great difference which therefore distinguishes them, is, that the former deals with the effects, the latter with the causes. Again, these small microscopic ferments are always in small quantities as compared to the substances on which they act, consequently a very small quantity of carbolic acid is necessary to prevent the decomposition of substances; therefore, its employment is both efficacious and economical.* Moreover, carbolic acid is volatile; it meets with and destroys, as Dr. Jules Lemaire says,† the germs or spores which float in the atmosphere, and vitiate it, but this cannot be the case with Condy's fluid, chloride of zinc or iron, which are not volatile, and which act only when in solution, and are mere deodorizers. This is why carbolic acid was used with such marked success, and therefore so largely, in England, Belgium, and Holland, during the prevalence of cholera and of the cattle plague;‡ Mr. W. F. Crookes, F.R.S., not only states,—“I have not yet met with a single instance in which the plague has spread on a farm where the acid has been freely used;” but he has also proved, by a most interesting series of experiments, that the gases exhaled from the lungs of the diseased cattle contained the germs or spores of the microscopic animals discovered by Mr. Beale in the blood of such animals; for Mr. Crookes having condensed on cotton wool these germs, and having inoculated the blood of healthy cattle with them, they were at once attacked with the disease. As to the value of carbolic acid for preventing the spread of cholera, among many instances which I could cite, allow me to mention two special instances: First, Dr. Ellis, of Bangor, says: I have in many instances allowed whole families to return to cottages in which persons had died from cholera, after having had the cottages well washed and cleansed with carbolic acid, and in no case were any of the persons so allowed to enter such purified dwellings attacked with the disease. My friend, Professor Chandelon, of Liège, has stated to me that out of 135 nurses who were

* See remarks at the end of lecture.

† See “Comptes Rendus,” 1867.

‡ See the third report of the Royal Commissioners on the cattle plague, and especially the valuable report of Mr. W. Crookes, F.R.S.

employed to attend upon the cholera patients—and they must have been numerous, for 2,000 died—only one nurse died, but the nurses were washed over and their clothing sprinkled with carbolic acid. In fact the antiseptic properties of carbolic acid are so powerful that *even rats* will prevent the decomposition, fermentation, or putrefaction for months of urine, blood, glue solution, flour, paste, faeces, &c., &c.;* and its vapour alone is sufficient to preserve meat in confined spaces for weeks, and even a little vapour of this useful substance will preserve meat for several days in ordinary atmosphere, and prevent its being fly-blown; lastly, *peas* has been found sufficient to keep sewage sweet, for Dr. Letheby states, in a letter addressed to me, that through the use of such a quantity of carbolic acid in the sewers of London during the existence of cholera last year, the sewers of the City were nearly deodorized. And I am proud to say that the British Government have decided to use exclusively our carbolic acid (as an antiseptic and disinfectant), not only on board her Majesty's ships, but in other Government departments; and that no other deodorant or disinfectant, such as chlorides of zinc or iron, permanganate of potash, or any disinfecting powder, shall in future be used for such purposes. Although questions of public health are the province of medicine, still permit me to say a few words on the medicinal properties of carbolic acid. This question deserves to be treated thoroughly, for phenic acid is susceptible of so many applications in this direction; its properties are so marked, so evident, and so remarkable, that they cannot be made too public, and it is rendering a service to mankind to make known some of the employments of so valuable a therapeutic agent.

I wish all who are listening to me were medical men, for I could show, by numerous and undeniable facts, the advantage they might derive from *pure* carbolic or phenic acid; and if my testimony was not sufficient to convince them, I would invoke the authority of men justly esteemed amongst you. I would recite to you the words of the good and learned Gratiot and those of Dr. Lemaire, showing that carbolic acid is the most powerful acknowledged means of contending with contagious and pestilential diseases, such as cholera, typhus fever, small pox, &c.† Maladies of this order are very numerous, but in carbolic acid we find one of the most powerful agents for their prevention, for besides many instances which have been cited to me, I may add that I have often used it in a family in which there were eight or ten children, and that none of

* See private reports made by Dr. Allen Miller, F.R.S., and Mr. Crookes, to Messrs. F. C. Calvert and Co.

† See Mr. Lemaire's work on Phenic Acid. Paris, 1865.

the family have suffered from those diseases except those who were attacked previously to the employment of carbolic acid about the dwellings in which such diseases existed. Besides its antiseptic action, the caustic properties of carbolic acid are found useful, for I may say most beneficial effects are obtained from it in the treatment of very dangerous and sometimes mortal complaints, such as carbuncle, quinsy, diphtheria, &c., as shown by Dr. T. Turner, of Manchester, and also in less severe affections, such as hemorrhoids, internal and external fistulas, and other similar complaints. But what deserves to be especially mentioned in the employment of carbolic acid is its power to preserve in a healthy state certain purulent sores, and prevent the repulsive odour which comes off from them, an odour which is the symptom of a change in the tissues, and which often presents the greatest danger to the patient. The services which carbolic acid renders to surgery can be judged of by reading several most interesting papers on compound fractures, ulcers, &c., lately published in the *Lancet* by J. Lister, Esq., F.R.S.; and allow me to draw your special attention to the following paragraphs which are to be found in his paper published in that journal of the 26th September, 1867:—"The material which I have employed is carbolic or phenic acid, a volatile organic compound, which appears to exercise a peculiarly destructive influence upon low forms of life, and hence is the most powerful antiseptic with which we are at present acquainted. The first class of cases to which I applied it was that of compound fractures, in which the effects of decomposition in the injured part were especially striking and pernicious. The results have been such as to establish conclusively the great principle that *all the local inflammatory mischief and general febrile disturbance which follow severe injuries are due to the irritating and poisoning influence of decomposing blood or sloughs*. These evils are entirely avoided by the antiseptic treatment, so that limbs which otherwise would be unhesitatingly condemned to amputation may be retained with confidence of the best results." Since the antiseptic treatment has been brought into full operation, and wounds and abscesses no longer poison the atmosphere with putrid exhalations, my wards, though in other respects under precisely the same circumstances as before, have completely changed their character; so that during the last nine months not a single instance of pyæmia, hospital gangrene, or erysipelas, has occurred in them." My hearers can also witness the same remarkable results by visiting the two sick wards of Dr. Maisonneuve, at the Hotel Dieu. Further, I must not overlook the valuable application made of it to gangrene in hospitals by the eminent physician, James Paget, Esq.; and lastly, it has been used by many of the most eminent medical

men with marked success in those scourges of humanity, phthisis and syphilis.

Agriculture.—Our firm has stimulated the employment of the carbolic acid for the cure of certain diseases very common to sheep—scab, for example. The method of treatment customary in similar cases was very imperfect as well as dangerous, whilst with carbolic acid this malady is cured, and without danger to the animal, by dipping it for a minute, often only for some seconds, in water containing a small quantity of carbolic acid. For this purpose pure acid would be too expensive, and is not used, nor concentrated acid, which ignorant men who have the care of sheep would not know how to use, but by the help of soap an emulsion of carbolic and creosylic acids is made. After having shorn the sheep it is dipped in this mixture; a single immersion in a bath containing $\frac{1}{2}$ of it is sufficient to effect a cure. After scab, foot-rot is one of the worst and most frequent complaints. Carbolic acid is also for that an efficacious remedy. For this a mixture is made of the acid and an adherent and greasy substance, capable of forming a plaster, which is made to adhere to the animal's foot for two or three days, preventing the contact of the air, allowing thereby time for the application to produce its effect. But if the flock be numerous, it would take a long time to dress the four feet of each animal one after another; so, to make it more easy, a shallow tray is made of stone, a sort of trough; this is filled with the medicated mixture, and the sheep made to pass through it; their feet being thus impregnated with the required substance. Permit me also to state that cattle cease to be annoyed with flies, &c., if washed with this solution, or a weak solution of carbolic acid; and a first-rate salve can be prepared by adding 10 per cent. of carbolic acid to butter, or any other fatty matters used for such purposes.

Manufacturers have not yet availed themselves of one title of the valuable properties of carbolic acid, and in this direction a new field is open to its employment; still I may cite a few instances. The preservation of wood has been already referred to, and, thanks to carbolic acid, the great trade in skins and bones from Australia, Monte Video, Buenos Ayres, &c., will ultimately be benefited, for, as you are aware, wild animals live there in herds and are slaughtered by thousands. Formerly the refuse of cattle, especially the bones, came to us in a bad state, half-putrid, emitting an insupportable odour, and only fit for manure; in this state their price was not more than 150 francs the 1,000 kilogrammes, now, with carbolic acid treatment, they arrive perfectly preserved; they can be employed for all the uses to which green or raw bones are usually applied, and the value of bones is raised as much as from 250 to 300 francs. Hides also often arrive putrid, although they have been dried rapidly in

the sun, or salted, which latter process, as you are aware, necessitates long and costly manipulations; whilst it is only necessary to immerse them for twenty-four hours in a solution of two per cent. of carbolic acid, and dry them in the air, to secure their preservation. It is probable that in a short time the blood, intestines, and other parts of these animals will be, by means of carbolic or phenic acid, converted into manure, and imported into this country. In England carbolic acid is used in the preservation of gels at the gut works, for keeping anatomical preparations, and the preservation of all animal matter. Carbolic acid is also utilised in preventing the decomposition of the various albumen, flour, and starch thickeners used in calico printing, as well as gelatine or bone size, employed for sizing fastens and other cotton goods.

One of the most interesting chapters in the history of carbolic acid is certainly that which relates to the production of colouring materials from it; they alone enter into comparison with those derived from aniline, and often enter into successful rivalry with them. Amongst the colouring matters derived from carbolic acid, the most important is, without fear of contradiction, *Picric acid*.

The discovery of this acid dates back to a distant period; it was studied by Welter, and was called Welter's bitter. But it was my illustrious master, M. Chevreul, who, in 1807, discovered the real chemical composition of picric acid, and who demonstrated that picric acid was often produced when organic matters were acted upon by nitric acid. Further, M. Chevreul discovered in the products of the oxidation of organic substances through nitric acid two different compounds, which he called *amer au minium* and *amer au maxime*, the latter being picric acid. This acid was again examined by Laurent in 1841, when he demonstrated that the true generator of picric acid was phenic acid; that in the action of nitric acid on the latter it formed three nitrogenated compounds, mononitrophenic acid, binitrophenic acid, trinitrophenic acid, the latter being also picric acid.

These interesting results of Laurent would perhaps have remained for a long time without any commercial value if picric acid had not been applied to dyeing, in 1847, by M. Guizon, senior, of Lyons. Since then the use of this acid, producing magnificent yellows, has been much extended, and what has contributed to its employment is that, conjointly with indigo, it gives ordinary greens, or of *vert Lussive* with Prussian blue, so that its consumption may be valued at from 80 to 100,000 lbs. annually; our firm alone produces more than 300 lbs. weekly; and when it is considered that 1 lb. of picric acid dyes to an intense shade 70 to 100 lbs. of silk, or 40 to 60 lbs. of wool, the enormous quantity of textile materials dyed by this single product may be appreciated.

The processes followed for the preparation of picric acid are still those which Laurent indicated in 1841; but instead of using carbolic acid, loaded with the heavy oils of tar, as M. Guizon had done, I sought to diminish the quantity of nitric acid, employed in mere waste, on the heavy oils of tar, which were then mixed with carbolic acid, and I am glad to say that I succeeded in doing so in 1849, by employing carbolic acid, containing only some of its liquid homologues. In 1856, M. Bobeuf took out a patent in France for the manufacture also of picric acid from carbolic acid. But picric acid was still at a high price, and it is only since our firm has manufactured cheap carbolic acid that picric acid can be produced free of resinous materials which prevent its purification and its being sold at a low price; in fact, owing to our pure carbolic acid, picric acid is now obtained chemically pure; this product, which was sold some years since at 16s. to 20s. per lb., is now sold at the rate of 3s. Further, I may add that to apply it in a quick and economical manner it is desirable to add to the dye bath a small proportion of sulphuric acid; this method of manipulation, which is not generally known, is very important, for it is only in this way that the textile materials can be readily dyed, and the baths exhausted.

I shall now have the pleasure of calling your attention to the production of two new colouring substances derived from picric acid:—

1st. *Picramic acid* was, in the first instance, obtained by Welter; by making sulphate of iron act upon picric acid, and neutralising with caustic barytes, when a deep brown salt was produced, from which he separated the baryta by the help of sulphuric acid, and thus obtained an acid to which he gave the name of nitro-hemic acid; but it is to M. Aimé Girard that we owe the practical process by means of which we are able to manufacture large quantities of picramic acid, viz., through the action of hydro-sulphate of ammonia on picric acid. Picramic acid imparts to silk a beautiful series of brown tints, similar to those obtained from catechu.

2nd. *Isopurpurate of ammonia*. It is with much pleasure that I noticed, at the exhibition, in M. Castelnau's case, a coloured substance known in the trade by the name of soluble garnet, and which, I am informed, is used especially by M. Chalmel, of Putaux; this substance is particularly remarkable, owing to its being isomeric with the *purpurate of ammonia or veratrin*. Although the preparation of this colouring substance was first pointed out by M. Carey, still it is really due to a previous observation by Hlaswitzer, who was the first to call attention to the reaction of cyanide of potassium upon picric acid, and thereby gave us the knowledge of manufacturing the isopurpurate for industrial purposes.

Before taking leave of picric acid it may not be without interest that I should state a curious application which has been made of the explosive property of its salts. During these last few years the picrate of potassium has been employed by Mr. J. Whitworth, for charging the shells used in destroying the iron plating of ships. When the projectile thus prepared strikes the iron masses, the enormous propelling force with which they are expelled from the gun is instantaneously converted into heat, and to such an extent that the shot becomes red hot, and the heat thus generated decomposes the picrate of potash, and a violent explosion ensues, owing to the enormous quantities of vapours and gases which are thus produced in an instant of time. Whilst the alkaline picrates are endowed with such formidable properties, they also possess others which are useful for the alleviation of human misery. Picric acid being an efficacious remedy in intermittent fevers. Persons affected with such types of fever, and upon whom quinine has lost all its beneficial effects by continuous usage of it (this is the case with some of our soldiers who return from India), derive, I am glad to say, wonderful benefit from the use of picric acid and picrates, as Dr. Aspland has proved to be the case at the military hospital at Dakinfield. The knowledge of this fact may be useful in districts in which poor populations exist, for it affords them a cheap febrifuge; and, moreover, picric acid is not dangerous, as arsenical preparations are, nor does it derange the stomach like quinine.

To return to the colours derived from carbolic acid, allow me to remind you that when, in 1834, Runge discovered phenic acid amongst the products of coal tar, he observed at the same time the existence of two colouring substances, to which he gave the name of *rosolic acid* and *brusolic acid*.

I will not detail here the processes by which Runge extracted these substances from the residue of coal tar by means of lime, nor the method adopted by Messrs. Smith, Dessart, and Jourdan for producing these substances by direct oxidation of phenic or carbolic acid, but will describe rapidly the process which we now use to manufacture *rosolic acid*, which, by the bye, should not be attributed, as is generally done, to M. Kolbe, the method being due to M. Jules Persoz, the son of the celebrated Professor of tinctorial chemistry in the Conservatoire des Arts-et-Métiers. His process consists in making oxalic acid act upon sulphophenic acid at a temperature of about 160 degrees, which gives rise to a product which has the bronze-green appearance of emtharides. To render it suitable for employment in dyeing it is only necessary to wash it so as to separate from it all the sulphuric acid with which it is contaminated, and then it is sold under the name of *Yellow Caralline* or *Aurine*. It was our firm who first, in 1863, discovered that rosolic

acid thus prepared could be employed directly as a dye, and introduced it to dyers under the name of *aurine*, and to printers to produce upon silk and albuminised cotton magnificent orange colours, like those of basic chromate of lead or of turmeric. In 1860 M. Persoz, junior, discovered also that if rosolic acid was heated under pressure with ammonia it gave rise to a red substance, which he called *Péonine*. Messrs. Guinon, Marnas, and Bonnet perfected the manufacture of *péonine*, and gave it the name of *Red Caralline*. This colouring substance imparts to silk and worsted a flame-coloured tint and brilliant scarlets. This firm were also the first to produce and introduce, towards the end of 1860, a blue dye, derived from carbolic acid, or, more so, rosolic acid, which they called *Aurine*, which is prepared by heating for several hours, at the temperature of about 180 degrees, a mixture of rosolic acid and aniline, and which is purified by repeated treatment with sulphuric acid and benzine, constituting, when dry, a red mass having gold-coloured tints. *Aurine*, although discovered before the *Aniline blues*, which have since become formidable rivals to it, is still, notwithstanding, manufactured in competition with them.

To Messrs. Guinon, Marnas, and Bonnet is also due the first production of a green derived from coal tar products. It was manufactured in 1863, therefore some months before the appearance of an aniline green, known as *Vert d'Aniline*, which, however, with the exception of the iodine greens, is the only one now employed in dyeing. *Vertine* was obtained by this firm from a mixture of aniline, benzoic, and rosolic acids.

Phenicienne, discovered in 1865, by M. Roth, is another colouring matter derived from phenic acid; it produces fast colours, from a deep garnet red to a golden buff. *Phenicienne* is produced by the action of nitrosulphuric upon carbolic acid.

I cannot conclude this retrospective review without calling your attention to a fact which seems to have escaped the attention of my colleagues; it is that the majority of the beautiful colours obtained from phenic or carbolic alcohol, or from aniline are due to the industrial application of a discovery made by your illustrious president, M. Dumas, more than thirty years ago. I mean the principle, so rich and fruitful, and to which he gave the name of "the law of substitutions;" a law which has thrown, as you are aware, such bright beams of light on modern chemistry, and which has prepared the way for such brilliant achievements, and which, I say, has also been the foundation of the production of those beautiful colouring substances which are derived from tar products, and which we all so much admire. Thus, in order to obtain aniline blues, violets, and greens, produced by the methods devised by the illustrious chemist, Dr. Hofmann, we

substitute for a certain proportion of the hydrogen of rosaniline an equivalent quantity of the alcoholic radicals, called phenyl, ethyl, methyl, and amyl. Further, this celebrated chemist has also shown that the blue obtained by Messrs. Girard and Delaire are also due to the same laws.

I am far, I regret to say, gentlemen, from having named all the remarkable properties and applications of carbolic or phenic alcohol; but I trust I have succeeded in making you share my enthusiasm for this valuable agent, which, after having rendered important services to most of the world's industries, still offers to chemists and to manufacturers a wide field for new applications.*

* Owing to the imitations which have been held out by some traders, large quantities of a fetid mixture have been sold to the public as carbolic acid. To enable purchasers to protect themselves from fraud, the following test is supplied on the authority of Mr. W. Crookes, F.R.S.:—"Commercial carbolic acid is soluble in from 25 to 30 parts of water, or in twice its bulk of a solution of caustic soda, while oil of tar is nearly insoluble. To apply these tests:—1. Put a teaspoonful of the carbolic acid in a bottle; pour on it half a pint of warm water; shake the bottle at intervals for half an hour, when the amount of oily residue will show the impurity. 2. Dissolve one part of caustic soda in ten parts of warm water, and shake it up with five parts of the carbolic acid. As before, the residue will indicate the amount of impurity. These tests are not given as having any pretension to scientific accuracy, but as affording persons who are desirous of using carbolic acid a rough and ready means of seeing whether or not they possess the right article."

THE

DWELLINGS OF THE POOR;

A PLEA AND PLAN

FOR THEIR IMPROVEMENT.

"Ye have the Poor with you always; and whenever ye will ye may do them good."—MARK.

READ BEFORE THE DOWNPATRICK LITERARY SOCIETY, AND
PUBLISHED AT THE REQUEST OF THE MEMBERS.

PRICE ONE PENNY.

BELFAST:
HENRY GREER, 31, HIGH STREET.
1896.

I GRATEFULLY INSCRIBE THIS LITTLE ESSAY TO

HENRY MACCORMAC, Esq., M.D.,

WHO, ON ALL SUBJECTS, ON ALL PROPER OCCASIONS,

MANFULLY DECLARED AND DEFENDED

HIS CONVICTIONS,

IRRESPECTIVE OF POPULAR OPINIONS;

AND WHOSE DISCOVERIES IN

MEDICAL SCIENCE,

AND UNTIRING LABOURS IN

SANITARY REFORM,

HAVE MADE MANKIND HIS DEBTORS.

E. G.

ADVERTISEMENT.

THE DOWNPATRICK LITERARY SOCIETY has been established for the mutual improvement of its Members; and is now in the third year of its existence. It has been founded on a wide basis, without either political or sectarian aim.

The Society possesses an excellent Reading-Room, provided with the leading Newspapers and Periodicals; and the Members have it in contemplation to add a Library to its means of usefulness, by the voluntary contribution of Books—a large number of which have been already promised. They hope that Gentlemen in the neighbourhood will assist in furthering their objects by a similar donation of Books for which they may have no longer any use—no matter on what subjects they may treat. The Society thinks that, by such a plan, a large and useful Library may be collected in one place, which could not fail to be a great public benefit.

The Society has added a Chess Club, for the amusement of its Members, which holds its meetings in a separate apartment once a week, and which is supported by a separate subscription from the Members who join it.

During the Winter, original papers are read once a fortnight by the Members, and afterwards the subject of the papers is conversationally entered upon. This gives rise to valuable information, and helps to impress on the memory the matters under discussion.

The following paper having met with the approbation of the Society they requested that it might be printed. With this request, I have complied; and I hope this small effort may have some effect in drawing public attention to a subject than which I know of none more interesting or more important.

EDWARD GARDNER.

Downpatrick, 1st January, 1866.

THE DWELLINGS OF THE POOR.

I HAVE chosen for my subject this night "THE DWELLINGS OF THE POOR;" for indeed it is lamentable to see the miserable state in which the people are lodged, and I think greatly to be deplored that habit has reconciled them to this miserable state. "Contentment" is said to be "great gain," but the *contentment* which arises from the force of habit—the ignorance which knows no better, or the apathy of hopelessness, in place of being a virtue, is, on the contrary, a degrading vice, and becomes the fruitful parent of many of the private and social evils of which society has to complain.

It appears to me, then, that the man who could render the mass of the people thoroughly dissatisfied with the condition of the dens they inhabit, would be a true benefactor of society. Until such a feeling pervades the people—until they become disgusted with the squalor, uncleanness, and discomfort of their surroundings, the causes of their degradation will never be sought out, nor the requisite means for their moral and social elevation carried into active operation.

If the inhabitants of this country had a consciousness that their dwellings were not what they should be—that they are deficient in the necessary requirements for the proper enjoyment of life, or the preservation of health—who does not see that the persistent manifestation and force of such public opinion would so act upon the owners of property that sooner or later steps would be taken to remove the prevailing abuses? And who could suffer from such a condition of the public sentiment? Certainly not the owners of property themselves, whose rentals would be increased in proportion to the higher and purer desires upon the part of the tenantry. Surely he takes a mistaken view of his own true interests who so manages his property that it will only be occupied by the most degraded class—whose dwellings are unfitted for the decent requirements of life, and unprovided with the necessary means for the nightly separation of the males and females of the family—thus breaking down in the homes of the people themselves that sensitiveness and delicacy of feeling, on the existence and preservation of which the virtue of the community can alone rest. I recollect being on a jury, when an *alibi* was proved, by the sisters of the accused, which

appeared to me at the time utterly incredible; but I learned from many of the other jurors that it was quite usual, among such a class, for grown-up brothers and sisters to occupy the same bed. This shocking state of things prevails, I believe, to a large extent; and where there are not three separate sleeping apartments, how can it be otherwise in families but that young men and women will occupy the same chamber, if not the same bed.

Having been appointed, in the early part of this year, one of the Officers of Health, for Downpatrick, in company with some of the Members of the Dispensary Committee, I made an examination of a portion of the town. I regret very much that, from certain causes which it is needless to specify, I was prevented from taking the active part the duties of the office required; and that I had not the opportunity of becoming personally acquainted with the internal condition of all the habitations of the people. But from what I did inspect—and I dare say it was a fair sample of the homes of the labouring class—I was indeed shocked to see how completely all the essential requirements for a proper sanitary state are violated in the humbler dwellings of the people.

From what fell within my own observation, I find that in many of the dwellings in this town there cannot be that separation, at night, of the members of the family which propriety would enforce; and that owners of property, who have the means of remedying this, should let habitations unprovided with the requisite accommodation in this respect, is a matter that you will pardon me not commenting upon. It is no excuse that they know nothing of the internal economy of the families which occupy their tenements; but I venture to submit, so far as the means for the due separation of the males and females of the family is concerned, it is a moral obligation to take care that these means are provided. Every moral consideration imperatively demands that a system so calculated inevitably to destroy the sensitiveness and delicacy of the female, should be most carefully provided against; and that in the homes of the people these great safeguards of propriety and purity should not first be neglected, and then, from mere habit, finally disregarded. Against this great and crying evil, the moral sense of the community should be directed, and public opinion, if need be, invoked against the perpetuation, directly or indirectly, of this state of things. For every reflecting man will discover that very many of the grave evils which afflict society have their origin in the unsuitable dwellings which abound in the country and towns; and which, from low rents, tempt the poor into their occupation, and thus lower the aspirations of those who make them their permanent homes.

It was well and strikingly observed, by an Inspector of

Police, in the City of London, before a Parliamentary Committee, on the Dwellings of the Poor, that, "if hogsheds were placed along Cheapside they would soon become inhabited, and with a population even more degraded than those occupying the deserted tenements;" because, as he said, "if you have undrained marshes and stagnant pools, these will be filled with suitable animals," and therefore he urged that "the only way to free society from degraded human beings is to provide no suitable dwellings for them, as the only way to get rid of the noxious reptiles inhabiting the marshes and pools, is to drain the one and fill up the other."

So influential upon character are the dwellings in which people reside, that no surer means could be taken to elevate and refine, than to render such thoroughly adapted for the decent requirements of life. Count Rumford, a man who devoted much time and great ability for the benefit of the poorer classes, from an enlarged experience, has observed that "no man scrupulously attentive to cleanliness could be a villain;" and every man's experience will tell him that the dangerous and disreputable classes are distinguishable from others by their indifference to personal appearance; and if, for the purpose of more successfully plying their dishonest and dishonouring courses, they should present a decent exterior—which second-hand clothing may give—we may be certain to find that, like "whited sepulchres," they are filthy and rotten within. Nothing would tend more to the speedy improvement of society than replacing the wretched habitations in which the poor now reside by suitable dwellings; and that this desirable end can be attained, what has been done in other places will abundantly testify. And as every good action brings with it its own happy reward, so would the owners of property be amply repaid by possessing a well-conducted tenantry and a remunerative rental. That there are great difficulties in the way of accomplishing this desirable end, I see as plainly as others; but, whether capable of being worked out or not—it will be for you, gentlemen, to judge,—I will, before I conclude, sketch out a plan by which it appears to me this consummation might be achieved. It is surely one great step in the way of social reform to know what would promote the welfare of the poor, and their moral elevation; and with this knowledge may we not hope to bring it into successful operation?

To pass now from the moral considerations involved in the dwellings of the people, let us consider the unsuitable condition of these with respect to the health of the community;—and here we may profitably allow ourselves to reflect upon the beautiful system of responsibilities pervading all the Providential arrangements of the social state, and the inter-dependencies which

govern our relations with each other. In the great connecting-chain which binds man to man, from the lowest to the highest, we cannot touch a link, no matter how near or how remote, that the movement is not felt throughout the entire; so, should we overlook or become indifferent to the welfare of others, our true safety or happiness will be sure to suffer. As regards the general health, this is exemplified in our zymotic and epidemic diseases; and if our arrangements are such as to engender these among the poor, their *locales* become centres whence infection radiates into the homes of the more affluent, whose duty it was to guard the less happily circumstanced from the causes of disease. And thus it is that an enlightened selfishness ministers to the good of others; and where higher and holier motives may prove to be unavailing, less worthy, but more personally operating influences, will be found working to the same end. And as

"The fear of hell is the Hangman's whip,
To hold the wretch in order,"

so does the fear of the twin scourges of Typhus and Cholera rouse up the wealthier classes to improve the condition of the poor, by removing the more obvious causes of disease and death.

In examining the residences of the poor, we find that almost every sanitary requirement is universally overlooked. To insure these, there should be perfect drainage, thorough ventilation, and abundance of light; without all these, it is impossible to have real cleanliness and sound health. The supply of water—which could not be too abundant—and the general sewerage properly belong to the whole community; and, therefore, if these be not provided in towns, the owners of house property are not specially responsible. But no house should be permitted to be inhabited the first floor of which is not perfectly dry, and the level of which is not higher than the approaches to it from the outside. Unless the floor be higher than the ground immediately at the entrances front and rear, it is impossible to have the dwelling free from damp; and this constant damp must give rise to exhalations which will be—it may be slowly, but certainly—destructive to the general health of the inmates. Many of the rheumatic, digestive, and cutaneous affections, which have their origin in the interrupted action of the skin, proceed from this cause.

Nor should any dwelling be unprovided with a yard at least 20 feet deep, by the width of the house, and at the farthest part of which, from the house, should be placed the dustpound and latrine. The floor of the latrine should be at least 3 feet above the level of the yard, and over the dustpound, and the seat of it should lift up, so that the dry waste of the house could be readily thrown over the soil, and thus in a great measure deodorize it; and, when its removal would become necessary, render it less

offensive than it otherwise would be. If this arrangement were adopted, and the roof of the latrine properly constructed with a view to the free circulation of air, then the latrine itself would become a funnel for the removal of all noxious gases and fetid odours, and discharge these at such an elevation as to mix freely with the atmosphere, and not find their way into the dwelling itself. If the sewerage of the dwelling must pass under the house, to find its way into the main sewerage of the town, it should be through well-glazed fire-tile piping, jointed with Portland cement, as built sewers cannot be made air-tight, nor kept free from the destructive action of vermin. The inlet to these pipes and sewers in the yards should be trapped, to prevent the dangerous gases of the general drains from finding their way to living men, of the destructive effects of which there were many painful and striking examples in this town itself.

In the construction of dwellings, one of the most important considerations is *thorough ventilation*. On no subject connected with health is there anything more valuable, and yet, unhappily, so little understood, or so much overlooked. The great mass of mankind are totally unaware of the quantity of unbreathed air required for the healthy action of our vital functions, or the essential part which it performs upon the organization of all living things. The atmosphere in which we move is an ocean so vast that all the active agencies we employ to pollute it, are as nothing when freely permitted to pervade it, while, at the same time, the surprising self-acting adaptations, which are constantly at work to render that which, for one division of nature, would be destructive, the source of vitality and sustenance to the other, points out in a striking manner the Supreme Wisdom which has contrived and formed all. To illustrate this, even in a small degree, it will be only necessary to state that the air which the animal world exhales, loaded as it is with the carbon eliminated, during the constant waste of tissue, and which, if not thus removed, would be fatal to animal existence, becomes the support of the vegetable world, and for which that great department of nature repays by giving off the vital air, on which the former depends for life and health. Thus we see that these two great divisions of vital organization are mutually dependent, in some measure, upon each other, and that what would be the cause of disease and death to the one, becomes the source of health and life to the other. I will not attempt to point out the glories which may readily be discovered by the inquiring mind, in that vast ocean in which "we live and move and have our being," nor the all-important part it plays in the economy of nature; for this would require an amount of knowledge which I certainly do not possess, and an amount of time

which you could not now afford to give; but I may ask you to reflect upon the enormous force it must possess, in retaining within its vast bosom the waters which descend upon the earth's surface—the winds which it causes to flow from one part of the globe to the other, thus commingling the different gases it contains, and distributing their life-giving energies, while, at the same time, it softens the lights and shades, and presents, in the sunsets and sunrises, and, in its floating clouds, beauties which captivate the least as well as the most instructed, and upon which the painter dwells with rapture, though he labours, almost vainly to represent them. How great, how sublime are the works of Nature,—with what a lavish hand are beauties scattered everywhere, from the minute to the vast, and how gloriously are our senses formed to harmonize with these inexhaustible treasures, and to see and feel in everything the perfections of Creation!

You will excuse this episode; but it is almost impossible to restrain oneself when the mind becomes directed to the harmonies of nature, and the beneficent and beautiful arrangements with which we are surrounded. But I must check myself, and return to the subject now more immediately before us, namely *thorough ventilation*.

From the inquiries made by "The Commission for Improving the Sanitary Condition of Barracks and Hospitals," published in 1861, it was found, in order to maintain the health of the soldier, it was necessary that each should have a space of 600 cubic feet, and a constant supply of 1200 cubic feet of air per hour, while, if in an hospital, the space and supply of air should be doubled.

In order to secure this amount of ventilation in apartments with *fire-places*, they recommend *inlets* from the outside at the ceilings, having one square inch of area for every 60 cubic feet in the first floor of buildings three stories high, for every 55 cubic feet in the second floor, and for every 50 feet in the third floor, with *outlets* of the same area, opening also at the ceilings, and connected with flues carried above the highest part of the buildings—the entrance of these *inlets* and *outlets* to be placed at the greatest possible distance from each other; the entering air to pass through perforations in zinc, and this zinc plate placed over a conduit inserted at an angle of 45 deg., so that the external air may be directed against the ceiling, and thus be distributed without causing sensible and unpleasant currents. The area of all the perforations to be at least twice the size of the area of the inlets. These proportions of the outlets are supposed to be able to remove 600 cubic feet of air per hour, and the chimney flue as much more, or 1200 feet in all.

In our mode of constructing houses, the system of ventila-

tion is extremely imperfect, and where apartments are closed in by doors nothing can be worse. So long as the doors and windows are shut, all the air that escapes up the chimney flue, streams into the chamber through the fissures in the wood fittings, connected with the doors and windows. This pure air from the outside falls at once from its gravity to the lower part of the room, and supplies the demand of the chimney at a level below the opening of the fire-place, while the pre-breathed air alone remains for those who shut themselves up in such apartments. Fortunately for the poor, their poverty, as regards ventilation, is in some measure their protection. The carpentry in all the openings of their houses is but imperfectly constructed. Their outer doors are generally kept open; and where there is a second floor the stair or ladder opening affords a free passage for the pre-breathed air to find its way out of the living room; but then, when they retire to the second floor, for the night, with the windows shut and no fire-places provided, ventilation is totally suspended.

Perhaps it may not be altogether unnecessary that I should state why *thorough ventilation* is so essential. This I have laid down in general terms, but the reason I have not specified. In all animal life there is a constant taking down and building up of the cellular tissue—every part of our bodies is being constantly removed and reformed; and these operations are performed during and through the circulation of the blood, and through the agency of the exhalent and absorbent systems. These supply the new tissue and remove the old, and these functions are discharged by special organs for special ends. But among these organs a large amount of duty falls to the share of the lungs. Into their cells the venous blood flows, after having gathered up from all parts of the system the effete materials which have fulfilled their duties; and, spreading this blood through these cells, the oxygen or vital air we inhale literally burns away through the walls the foreign materials combined with the venous blood. By this process the venous blood becomes purified, and changed into arterial. The supply of arterial blood is renewed through another process by the food with the elementary and life-sustaining materials of the body. By this incessant action of oxygen in the lungs, the waste of the body is removed; and the product of this combustion is the carbonic acid gas which we expire. Now, this gas becomes fatal to animal life, as it cannot continue the combustion which is necessary to remove the effete matter from the blood, which, remaining there, would speedily destroy life; and hence the dangerous consequences of inhaling pre-breathed air. This re-breathing the same air is destructive to animal life in two ways; first, by the non-production of animal

heat, and, next, by allowing the carbon to remain in the blood, and pass again into the arterial circulation. So deleterious is the latter, that Dr. MacCormac holds that the unburnt carbon, remaining in the blood, gives rise to lung disease, or those affections of the glandular system which are termed scrofulous. Whether this view of Dr. MacCormac's, as regards the sole exciting cause of scrofula and consumption, be sound or not, it would be absurd in me to pronounce; but that breathing impure—or, rather carbonized—air is a fruitful cause of consumption and scrofula—those fatal diseases which carry off prematurely from one-third to one-half of those who die—every experienced physician will admit. You will readily see now how all-essential it is that the blood should be perfectly decarbonized; and this it is impossible to effect, unless the lungs have a sufficient supply of vital air, day and night, and that the carbonic acid gas which is expired should be at once removed from where we live.

That Nature herself has arranged to accomplish this, a little attention to the process of breathing will abundantly show. The temperature of the expired air is very high, and, as a consequence, rises at once so as not to be again taken into the lungs, while the expiration gives such a velocity to the air, that it is projected out of the way of the nostrils and mouth. Besides, which is all important, there is an interval of time between the inspiration and expiration of sufficient duration to enable the air in the lungs to perform its wonderful chemistry, and to remove it out of the way of being again re-inhaled. Who cannot see in this arrangement a wise provision to accomplish an all-important end? and, reflecting upon this, are we not very culpable if we overlook the lesson which it so obviously teaches?

I might add a great deal more upon the necessity of perfect ventilation, which every man will admit, but which very few practically carry out. That this is so, a visit out of the pure air into the sitting-rooms and bed-rooms of all classes would abundantly prove. With doors, and above all with windows, closed, the living rooms are rendered positively poisonous and offensive; but as the vitiation proceeds slowly, the inmates are unconscious of the state of the apartments, and thus the seeds of many serious, and, mayhap, fatal diseases are sown, through a mistaken idea of comfort, or positive and culpable ignorance. But before passing from this, I would earnestly call your attention to the enormous amount of vital air which our gaslights consume, and of carbonic acid gas which they produce. The apartment, no matter how spacious, if well lighted by gas—unless by the "sunlight system"—becomes in a very short time utterly unfit for healthy respiration. The exhaustion and lassitude which ensue are far more due to the impurity of the

air than the dulness of the people among whom we may be placed, or the inability of the performers to instruct or amuse.

Passing now from the subject of ventilation, I come to consider the importance of light. So far as this great and active agent is concerned, we see how completely ignored is the provision for its ample admission into the dwellings of all classes, but more especially into those of the poor. Legislation, even a few years ago, banned it. This was not done, as might be supposed, from motives of ill-will to their fellow-countrymen; but from the sheer ignorance of the men in power. Happily, the window-tax and the duty upon glass have been taken off by the better-informed legislators of our day, and this encourages me to think that no grievances and no laws prejudicial to the real welfare of mankind can be maintained after their true nature becomes generally known, and the public voice demands their removal.

Light has a more powerful influence upon living organisms than the great bulk of mankind ever imagine. All are aware that in the vegetable world plants are blanched by its exclusion, and that to its presence the beautiful colours, that captivate the eye in our gardens and fields, and throughout the boundless domain of Nature, are altogether due. But few know that to its mysterious agency are owing the development and forms of animal life. Were we to take the frog, for example, in its tadpole state, and carefully exclude the light from it, the form it otherwise would assume would not be developed. It would, no doubt, increase in size, but it would remain the tadpole still. In the mines of Russia, where in that rigorous climate the miners took their wives to reside, the temperature being so inviting, it was found if women remained during the period of gestation, their children were imperfectly developed. So melancholy was the result arising from living in the absence of the light from heaven that the Government interfered, and made it a penal offence for women under such conditions remaining under ground. These striking and startling facts may give us some notion of the part light performs in the animal kingdom, and how carefully we should guard against its exclusion. The Albert bed, with its low position, small canopy, and graceful drapery, has fortunately replaced, in the mansions of the better informed, the high four-posted bed, with its surrounding heavy curtains, in which, a few years ago, the sleeper was partially poisoned; but still we find, in the houses of the wealthy, light carefully excluded as an enemy, by the ingenuity and bad taste of the owner and upholsterer; and in the cabins of the poor by wretched substitutes, where there should be ample openings for the admission of light. Were it not that the buoyancy of childhood, and the

promptings of instinct, force the young to seek their amusements out of doors, the human race would be stunted in form, colourless in appearance, and soon perish off the face of the earth. Nature, ever careful, calls upon childhood to rush into the pure outer air, and the life-giving light; and thus secures the healthy employment of all the muscles in their natural direction, under the fancy of being engaged in mere play. In this happy delusion, an exposure to the unbreathed air and pure light of heaven, and an amount of positive labour are secured, which, at this important period of life, give development and health to the system, and which neither reason nor force could otherwise accomplish. Thus, after all, we are more indebted to the instinctive promptings of Nature for the preservation of the race in health and physical beauty, than ever enters into the apprehensions of the parents and teachers of the young.

I need not dwell longer upon the necessity of an abundant admission of light. I have shown its importance upon the physical organization of animals; and there only remains a word or two to be said as to its influence upon the habits and morals of the people. I have already drawn attention to the close relation which subsists between physical and moral impurity; and, as the Quaker said, "it is other people's eyes which cost us everything," so let light flow into all parts of our dwellings, and filth will be removed, and cleanliness universally prevail.

I have, as far as my knowledge would enable me to go, examined into the cost of *suitable* dwellings for our industrious and labouring classes; and I feel persuaded houses may be constructed so that a rental of 1s and 1s 8d per week will pay 8 per cent. upon the outlay. These houses will have a scullery, in which all the domestic work can be done, so that the living room may be kept in comfortable and proper order, together with a separate sleeping apartment for husband and wife, for the smaller rental; while, for the larger, three bedrooms can be provided for the proper separation of the male and female members of the family.

The question now arises, can the dwellings of the poor be made such that the moral and physical condition of the poor can be improved and elevated? This is a subject of pressing importance, and ought to command the warmest interest among all classes. Few reflect upon the relations of society, and how intimately associated all are with each, and how much the rich owe to the poor. The general impression is that the rich support the poor; but, looking into facts, we cannot fail to see that we all are indebted to the men who work, for everything which we possess. What is wealth but accumulated labour? and the advantage arising from this accumulation ought to be enjoyed

by all who have contributed to it. Do not misunderstand me: I know that the whole welfare of society depends upon the security of property, and its individual possession; that it is this which causes accumulation, and without accumulation civilization could not exist, and, in fact, everything would lapse into barbarism and anarchy. Capital, or accumulated labour, which are one and the same, is the *past* savings for future and immediate wants; but all this has been created by the hands and heads of those who labour in the wide domains of industry. The mere spender dissipates this fund; and though he may be in abject poverty, or rolling in wealth, his existence has added nothing to, but, on the contrary, wasted much of the capital on which the welfare of all depends. The rights of property—whether of goods or of life—are the most sacred of all rights; and to the maintenance of those rights the wisdom of all nations that have gained a place in the history of our race, has at all times applied itself. The great leading truths of civil law have been developed in the progress of civilisation, and will be found in the Roman Codes, which remain, and ever will remain, the foundation of jurisprudence; subject of necessity to the ever varying niceties to which the ever varying combinations of society, in its complicated relations, will give birth. But these combinations are capable of being reduced into their elements, and thus brought within the boundaries of established principles. These constitute the rulings of the Judges, and become as much "law" as if laid down in positive statutes. Such must ever be the case; and hence the impossibility of reducing the laws of nations into simple codes.

But to return to the subject of capital and labour. We see that all which constitutes wealth has been the result of human labour, directed by intelligence. In the earlier stages of society this labour has few tools to facilitate its action; and, therefore, the condition of all is one of equality—but an equality on the confines of famine. As years roll on, some arise more ingenious than others, and some more far-seeing. These two classes take a position of superiority, and are more or less able to command the labour of others. Thus property becomes recognised; and the more secure its possession, the greater are the benefits which it confers upon all. But still it will be seen that this property is only a means to an end; and that without the continued action of the labourer it could not avail in supplying the ever-recurring wants of the community. I need not pursue this further. I have introduced it to show that the labourers, whether by hand or by head, really support and supply the wants and desires of all. Without them, whether in the humblest rank or in the rank of skilled labour, we would neither have food nor clothing, houses

or medical attendance, the ennobling influence of literature, arts, or science, or the security of life and property which the impartial administration of wise laws confers. Let us, then, not view otherwise than with respect and gratitude, all classes of the working members of society, no matter in what rank they may stand. They are the bees of the hive who labour for the good of each other; and by whose energies the drones, as well as the helpless, the afflicted, the aged, and the infirm, are fed, clothed, and preserved.

You will recollect, gentlemen, that in the early part of this paper I promised to sketch out a plan by which I thought the dwellings of the people could be made suitable to their wants and position: I will now proceed to do so with as much brevity and comprehensiveness as I can, feeling that I have occupied your attention too long already.

Among the more promising schemes of the day, I observe Building Societies are taking a prominent place. These, conducted with due caution and integrity, are no doubt well calculated to confer inestimable advantages upon a certain class; but they do not meet what I believe I have in this paper shown to be the more pressing requirements of society. They are admirably calculated, no doubt, to benefit those who, with the assistance these societies can confer, are able to protect and advance their own position by a wise and prudent foresight; but it is no part of their object to undertake—except, perhaps, indirectly—the improvement of the dwellings of the poor.

Now, I think what could be effected by conjoint action is the improvement of these dwellings; and, by such improvement, the general elevation of the labouring classes in the social scale. Though this consummation would be most praiseworthy, I do not mean to place it upon the grounds of mere charity or benevolence, but upon the more business-like basis of a profitable employment of capital.

It will be found in all towns that a large portion of the humble dwellings is the property of persons in an humble position, who have only the rents derivable from these tenements upon which to live; and who, consequently, have not the means to make the habitations what they should be. Nor have these small landlords either the influence or power to press upon the public authorities those external improvements which fall within the province of the whole community. Therefore we find that the streets, lanes, and suburbs, in which the poor reside are neglected, and the necessary outlay to cleanse, drain, and sewer, persistently refused. There are others, owners of this description of property, who are wearied by its management, or utterly indifferent as to the character or habits of those in its occupation.

These employ an agency to collect their rentals; but refuse all interference or outlay which they can possibly avoid. Again, property is constantly changing its ownership; and many by inheritance become landlords, who would gladly disburthen themselves of its cares and responsibilities. Among all these classes it may reasonably be expected that there would be many disposed to sell upon fair and equitable terms.

Now, could there not be in all our towns societies organised to buy up this description of property as it would come into the market, and by a judicious outlay upon well arranged plans, and with ample command of capital, rebuild the miserable hovels that disgrace these towns, degrade their inhabitants, and by their damp and total want of all sanitary requirements, cause their unhappy occupants to fall early victims to disease?

If such an organization as this were once commenced and judiciously worked—while it would make a fair return upon the capital employed—a quarter of a century would not elapse until the whole appearance of our towns would undergo a happy change. The houses would become healthy dwellings; disease, in its most deadly forms, would be largely diminished; the moral tone of all classes greatly elevated, and many of the vices and crimes of society disappear. But let the present state of things continue, the very progress of trade and manufactures, by over-crowding the unsuitable abodes of the people, will only aggravate the evils under which we labour, necessitate the enlargement of our police arrangements, and call into painful activity the repressive resources of the law, to partially remedy diseases which wiser arrangements would prevent from arising.

With suitable dwellings the taste for cleanliness, decency, and self-respect would be fostered—the homes would become attractive to the heads of families—the grosser pleasures sought for in the public-house would be estimated at their proper worth, and a general desire to rise in the social scale would be a pervading principle amongst all.

Education, which is now placed within the reach of the poorest, would be eagerly sought by parents for their children; and the enlarged views consequent upon a knowledge of the mere geography of the earth, and the illimitable fields which it contains for the profitable employment of labour, would point out to a surplus and enlightened working class where they could remove themselves, to secure in greater abundance the rewards of industry; while, at the same time, the supply of labour would not be in such excess at home as to reduce and keep the wages to what merely holds the body and soul together, and that, too, for a period far short of what is intended by a bountiful Providence. The ultimate result of all this would be a higher civil-

sation—a development of mind which would enable us to bend, control, and direct the forces of Nature, by our intelligence, to perform the tasks which are now accomplished by physical action; and thus, by the mere exercise of ingenuity, the laborious exertions which tax to the uttermost the powers of the labourer, and frequently shorten life or afflict it with disease, would be performed better and cheaper by the docile and obedient intervention of inanimate machinery. Look at one of the triumphs of the inventive genius of man, the Railway Train. See with what ease that mighty mass is carried along, and with what speed; and reflect that one of the powerful forces which Nature has thus placed at our disposal is called into action and controlled without the exertion of physical or continued labour by the Engineer. There is, there can be, no limit to the application of ingenuity in lessening—indeed, in rendering unnecessary—the exertion of mere physical force, on which we are now so painfully dependant, and to exercise which the vast majority of mankind, by our present arrangements, are now compelled. But is it not delightful to think that the time rapidly approaches when the muscular force will be superseded by the forces of Nature directed by the ingenuity, intelligence, and knowledge of Man?

With reference to the organisation of the Societies I contemplate, I need not go into details. Every one knows how such Companies are established, and how they could be conducted; but, unless I am far mistaken, I think I see in such united efforts a practical way to strike at the root of the social evils which afflict and demoralize the vast majority of our fellow-countrymen, and carry them prematurely to the grave.

I have now drawn your attention to the "Dwellings of the Poor." The theme is not one upon which your feelings could be excited or your fancy captivated, even had I the power, which I possess not, to interest your imagination. But, notwithstanding the imperfect manner in which I have treated the subject, I am greatly deceived if we will not, one and all, give, for the future, the dwellings of the poor more careful consideration, and feel a deeper and wiser interest than may have been felt by us before, in contemplating the influence which these exert upon the moral and social condition of the people. I resign the subject now into your hands, and I await with pleasure the expression of your views. I am persuaded, in the discussion which will follow, and which has always so interestingly and so instructively followed upon the reading of the papers before this Society, much valuable information will be brought before us, which cannot fail, though it may be in an humble degree, to render our proceedings this evening useful and beneficent to the great and sadly-neglected mass of our fellow-men in every country and in every clime.

POSTSCRIPT.

On reconsidering what I have said relative to the opening of windows for ventilation, I think it may be useful to observe that such openings should embrace the *lowering of the upper part of the sash*. This is particularly important during the night. Let any one observe the manner of ventilation adopted by almost all, and it will be seen that if the *lower part* of the sash be raised a few inches this is considered quite enough. Now, to prove the total insufficiency of such openings to change the air of the apartment in any reasonable time—and never let it be lost sight of that *stagnant air is impure air*—fill the chamber with smoke, which may readily be done by plunging a red-hot poker into a pot of tar, and it will be found that a long time will elapse before the smoke is entirely removed. If, however, the upper part of the sash be lowered, and the under part raised, or the door thrown open, the smoke will speedily disappear, and the chamber be refilled with pure air from the outside.

I think it necessary to direct attention to this, from having observed in this Town, the windows of houses in which Typhus Fever was carrying off the inmates, carefully closed, or a few inches merely of the *lower sash* raised. Nay, I have seen the window-blinds down, and the windows altogether shut, of the chamber in which the dead were being waked. Who need wonder, then, that infectious diseases should spread among the members of such households?

A few years ago, Typhus Fever was committing awful ravages in one of our Workhouses in the North of Ireland; some of the Nurses, and the Doctor himself, fell victims to the fell disease, and when another medical gentleman was called in, to his great dismay he found the windows had not been opened, and would not open, but with a promptitude and firmness which he knew to be necessary, he at once broke away every pane of glass, admitted the life-preserving air of heaven, and, in a short time, overcame the pestilence which had been so fatal. Will it be believed, and yet it is true, the *enlightened* Guardians of the Union called upon him to replace the glass he had destroyed? The law, however, protected him from this extraordinary claim; and this shows how little even men of position and influence know of the laws of health.

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1867.

QUININE

AS A
PROPHYLACTIC AGAINST MALARIAL FEVER:

BEING AN
APPENDIX

TO THE
THIRD REPORT

ON
Typhoid and Malarial Fevers,

DELIVERED TO THE
SURGEON GENERAL OF THE LATE C. S. A., AUGUST, 1864.

BY
JOSEPH JONES, M.D.,
Professor of Physiology and Pathology, Medical Department University of Nashville, and
Health Officer, City of Nashville.

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1867.

Southern States. The value of Quinine in warding off climate fever, is still farther demonstrated by the experience of the Surgeons of the British Navy on the coast of Africa. Facts proving the unhealthy nature of the climate of Africa—the malarial fever of Africa similar in all respects to the malarial fever of the low-grounds, swamps and rice-fields of the Southern States. Comparison of the mortality in the British Navy before and after the use of Quinine as a preventive of African fever. Observations made during the progress of the present war. The value of Quinine as a prophylactic in preserving the efficiency of troops serving in damp, unhealthy, malarious regions, demonstrated by a direct calculation. Table illustrating the numerical relations of malarial fever to other diseases, and its effects in reducing the strength of the command serving at Fort Jackson and the surrounding river Batteries, situated in the low rice lands of the Savannah River. Calculations based upon these facts. Throughout the entire period of 15 months, more than one fourth of the command were unfit for duty: during the fall months, more than one half of the garrison was on an average incapable of performing military duty. The utility of the use of Quinine as a prophylactic, demonstrated beyond all cavil, even as a mere matter of dollars and cents. The argument upon the score of humanity. The proper mode of administering Quinine as a prophylactic.

Testimony of various officers; of Assistant Surgeon J. N. Warren, of the 25th Regiment South Carolina Volunteers; of Surgeon Octavius White, of the South Carolina Palmetto Battalion Light Artillery; and Surgeon Samuel Logan, Chief Surgeon 2d and 3d Military Districts.

At the commencement of the recent war, I prepared and published the following article in the Southern Medical and Surgical Journal, entitled, "Sulphate of Quinia administered in small doses during health, the best means of preventing Chill and Fever, and Bilious Fever, and Congestive Fever, in those exposed to the unhealthy climate of the rich low-lands and swamps of the Southern Confederacy." Owing to the state of the country at the time, this publication was not circulated in the manner designed.

The climate of the rich low plain, clothed with a luxuriant sub-tropical vegetation, which forms a belt along the Atlantic Ocean and Gulf of Mexico of varying width, from 30 to 100 miles and which is intersected with numerous swamps which discharge their waters into sluggish, muddy streams, surrounded on all sides by extensive swamps and marshes, is necessarily hostile to the white race. To the pestilential exhalations of stagnant swamps and rich river deposits, excited and disseminated by the burning rays of the sun in this hot climate during the summer and fall months, no process of acclimation has ever accustomed

the white man. In the early settlement of South Carolina and Georgia, the inhabitants in most instances resided the whole year upon their rich rice and indigo plantations; many, however, soon fell victims to the climate, or dragged out a miserable existence, with constitutions broken and rendered prematurely old, by repeated attacks of climate fever. The clearing of the forests, of the swamps and rich low-lands, and the consequent exposure to the sun of the vegetable matter which had been accumulating for ages, rendered the climate so deleterious to the white race, that the planters were compelled to seek health during the summer and fall months, in sea island, or in pine barren, or mountainous retreats; and with the most efficient precautions, the mortality of these regions is far greater than in the more elevated portions of the Southern States.

The following facts will illustrate the effects of the climate of the swamps, rice fields and river bottoms, upon the mortality of the white race.

In the Midway Congregational Church, of Liberty co., Ga., (formerly St. John's Parish) the number of births from 1754 to 1804, was 600, whilst the number of deaths during this period was 628, thus showing an actual decrease during 50 years of 28. In 1817 there were 49 deaths in this congregation, which did not number more than 340 whites, showing a mortality of one in every seven of the inhabitants (14.4 per cent.) of the 49 deaths, 34 occurred in four months, July, August, September and October, and were in almost every case the effects of climate fever: and other years might be cited in which, if the mortality did not rise to so high a figure, it still rose to such alarming figures, as from one in every ten, to one in every seventeen inhabitants.

This heavy mortality was clearly referable to climate, for it is believed that no body of citizens in the Southern country excels this congregation in intelligence and virtue, or in the careful regard for the substantial comfort and health of its families.

Before the Revolutionary war, whilst Sunbury on the coast of Georgia, was in a highly prosperous condition, 70 emigrants came from the Bermuda Islands: of this number 50 died the first year from climate fever.

Savannah, situated on a sandy plain, terminated on the north

by a turbid sluggish stream, and flanked on the east and west by extensive tide swamps, afforded during the period that these low lands were cultivated in rice, a good field for the determination of the probable mortality of troops exposed to the climate of rich river-bottoms and inland swamps. The dry culture system was commenced with the lands surrounding Savannah, in 1818; we shall therefore for our present purpose, deal with the mortuary records of the city, and during the wet culture system, as far as they extend back from 1818: premising, however, that after the institution of the dry culture system, the health of Savannah, excepting the years when the yellow fever prevailed, has progressively improved, and will now compare favorably with cities situated in the same latitudes, and surrounded by similar alluvial deposits. After a careful examination of the records of the city, I have been able to discover no record of date earlier than 1804.

The deaths of the blacks are excluded from the following statistics. The sum of the deaths of the foreigners and natives, does not always correspond with the total deaths from climate fever, because, in some instances, the nativities are not given in the record.

DEATHS AMONGST THE WHITES IN SAVANNAH FROM 1804 TO 1818.

Year	Deaths during the year from climate fever	Deaths from other causes	Deaths of foreigners	Deaths of natives	Total Deaths
1804.....	118	77	63	14	207
1805.....	141	112	78	23	328
1806.....	120	92	43	9	169
1807.....	124	80	71	9	220
1808.....	108	77	67	8	219
1809.....	98	63	52	9	183
1810.....	79	46	38	8	165
1811.....	114	87	78	13	212
1812.....	182	120	92	24	226
1813.....	109	64	45	19	214
1814.....	185	166	138	23	300
1815.....	140	130	104	18	233
1816.....	161	146	91	28	272
1817.....	283	313	236	67	461

The population of Savannah in 1800 was 5,166; of these 2,799 were whites and 2,367 slaves. In 1808 the population was 6,464; of these 3,010 were whites and 3,454 slaves. In 1810, the entire population was 5,215; in 1820, entire population 7,523.

Whilst the records of the population of Savannah at different periods are not as full and explicit as could be wished, still from the data now presented we may institute comparisons, and determine the average mortality for each year with a very close approximation to the absolute numbers: thus in 1804, the proportion of deaths in round numbers of the whites to the white population, was 1 in 13; 1805, 1 in 12; 1806, 1 in 18; 1807, 1 in 12; 1808, 1 in 13; 1809, 1 in 16; 1810, 1 in 18; 1811, 1 in 14; 1812, 1 in 13; 1813, 1 in 14; 1814, 1 in 10; 1815, 1 in 14; 1816, 1 in 13; 1817, 1 in 9.

If we compare the mortality from climate fever, of the strangers and foreigners, under which class we include the seamen, who form a large part of the transient population of Savannah, we will see that the deaths amongst this class were more than four times as numerous as the deaths of the natives. This fact illustrates still more strongly the great risks and sickness, if not heavy mortality, which must attend the transportation of troops from Middle Georgia, and from any part of the high mountainous tracts of the Southern States to the swamps and rich rice grounds, during the months of July, August, September and October; for without doubt the observation was made by the reader as he reviewed the preceding figures, that the rate of mortality in Savannah during the wet culture system, frequently rose to a figure which in healthy regions would have been considered as the results of pestilence; and the correctness of this observation is placed in the clearest light, when it is known that the annual mortality in England* is one in every 45 of the living; in France, 1 in every 42; in the New England States, 1 in 64; in the Middle States, 1 in 73; Coast planting States, 1 in 73; Northern States 1 in 80. †

Whilst we will readily grant that the improved method of

*Sixth Annual Report of the Registrar General of England, 1847.

†Census of United States, 1860.

medical treatment of the present day would greatly diminish the rates of mortality, we would on the other hand affirm that these improvements in practice would have little to do with the prevention of disease. We have therefore presented this view of the rates of mortality in these localities, rather to demonstrate the liability of men exposed in this climate to disease, and thus to establish the importance of the present inquiry; for an army may be rendered almost as ineffective by sickness as by death.

The medical statistics of Oglethorpe Barracks during the period they were situated one mile south of the city of Savannah, just back of the present jail, illustrates still more forcibly the sickness and mortality of troops encamped in localities surrounded with rice fields and marshes. In 1828 during the months of July, August and September, there occurred 23 deaths in a command of 95 men; and during the months of October, November and December, 18 deaths in a strength of 85 men; the total deaths for the year was 52, besides 19 women and children—Remittent fever and dysentery were the fatal diseases which caused the high mortality. During 10 years, from 1829 to 1839, the annual ratio of mortality was 5.5-10 per cent; the annual ratio of Intermittents was 67 per cent, and that of Remittents 22 per cent; and every man was on an average during this period, reported in a little less than every five months. So prevalent and fatal were the diseases in summer and fall seasons, that this post was finally abandoned.

The Medical statistics of the Augusta Arsenal whilst it was situated on the banks of the Savannah river, correspond with those of the Oglethorpe Barracks; disease prevailed to so great an extent that it was necessary to abandon the post in the summer season, and encamp on the Sand Hills.

These observations might be still further strengthened by the presentation of the rates of mortality of rice plantations, this subject, however, will be treated more fully, hereafter, and we will merely state the result of an extended personal examination of the mortuary statistics of rice plantations; the number of births in proportion to inhabitants does not differ materially from the number in the healthiest re-

gions, but the mortality, especially amongst the young is far greater—in fact so great that during many years instead of an increase, there is either a stationary condition, or an actual decrease.

The facts which have now been presented are sufficient to justify the attempt to devise some means to ward off the climate fever.

During the study of the relations of climate and soil to disease, the collection of the mortuary statistics and the investigation of the causes of diseases upon rice and cotton plantations; and during the discharge of the duties of Chemist to the Cotton Planters' Convention of Georgia, the author has necessarily been greatly exposed to the agents which produce climate fever, and the results of his experience now presented, cannot therefore be said to be wanting the test of actual experiment.

Under these exposures I have found that Sulphate of Quinia taken in from 3 to 5 grains twice during the day would, in most cases, prevent the occurrence of Malarial Fever, and if it failed to ward it off entirely, the attack would be of a very slight character. I have still farther observed that when the climate fever first appeared, with a sense of lassitude, headache and excitement of the pulse, with alternate flushings, it might be arrested by a dose of from five to ten grains of Sulphate of Quinia, in combination with Bicarbonate of Potassa and Hoffman's Anodyne. From 5 to 15 grains of the Sulphate of Quinia may be given, according to the urgency of the symptoms, united with 15 grains of Bicarbonate of Potassa and 15℥ of Hoffman's Anodyne. From 5 to 15 grains of Gum Camphor; the whole to be dissolved in 15vi of water. The feet should be placed in hot water immediately after, or before, the administration of the remedies, and the patient after this bath should be covered up in bed, so as to promote free perspiration and induce quiet sleep. I have frequently gone to bed in a feverish, restless state, with a severe headache, excited pulse, and pain in the limbs, and dry, warm skin, and under the action of these remedies, arose in the morning refreshed and able to resume active operations. The Bi-Carbonate of Potash is here recommended, instead of the

Porto-Carbonate, (Salts of Tartar,) which is in such common use, during fever, in the Southern country, because it is far less active in its effects upon the stomach, and may be taken in much larger doses, and accomplishes more effectually the neutralization of the acid which is so often abundant in the stomach at the commencement of malarial fever, and more effectually acts upon the liver and the kidneys, and promotes the removal of all offending matters from the blood.

The late lamented Dr. Charles West, of Savannah, informed me that during his practice in Burke County, it was his custom to arrest attacks of climate fever, at the outstep, when the first symptoms were manifested, by Sulphate of Quinia; my former colleague, Dr. Dugas, Professor of Surgery in the Medical College of Georgia, informed me that he has used this medicine in a similar manner; and we have been informed that the energetic Superintendent of the Savannah & Charleston Road, which passes through a most sickly region of country, preserved the health of his white laborers by the daily use of small doses of Sulphate of Quinia.

We would recommend the use of Quinia as a preventive of Climate fever, in the following manner:

℞. Sulphate of Quinia,	- -	grains, iii.
Dilute Aromatic Sulphuric Acid,	- -	drops, v.
Brandy,	- - -	tablespoonful, i.
Water,	- - -	wineglassfuls, ii.

Drop the diluted Aromatic Sulphuric Acid upon the Sulphate of Quinia, and then add the brandy and water. Administer twice during the day, after rising in the morning, and just before bed-time.

To render the value of this means of warding off climate fever still more evident, we will cite the practice and success of the British Surgeons upon the coast of Africa, premising at the outset, that the endemic climate fever of Africa does not differ in any essential manner, except, perhaps, in its severity, either in its causes, symptoms or effects, from the malarial fever of North America.

The value of Sulphate of Quinia in warding off the climate

fever of Africa, can be determined only by instituting a comparison between the effects of the disease before and after the use of this medicine as a prophylactic.

The celebrated traveller, Mungo Park, suffered from two severe attacks of fever, upon his first tour through the interior of Africa, and at the conclusion of his journey the color of his skin was so altered by the disordered state of his liver induced by African fever, that he could scarcely be distinguished from a Moor; and upon his second visit to Africa, not only was he brought to the borders of the grave by climate fever, but 32 out of the 38 men who left with him the banks of the Gambia, fell victims to African fever in less than two months.

The vessel sent out in 1618, to relieve the English Explorer, Thompson, on the banks of the Gambia, lost almost the entire crew with fever, and at the very outstep, failed to accomplish the desired object.

The enterprising traveller, Ledyard, who had spent his life in travelling, and had sailed around the world with Captain Cook, had lived for several years with the North American Indians, and had travelled from Stockholm, round the Gulf of Bothnia, and thence to the remotest parts of Asiatic Russia, died of African fever, in the very commencement of his journey to explore this continent.

Numerous other travellers might be mentioned, as Nicholls, Morrison, Pearce, Clapperton, and the active, athletic and temperate Frederic Horneman, who fell victims to the endemic climate fever of Africa.

The splendid expedition to the Congo, under command of Captain Tuckey, provided with a crew of fifty active individuals, and with a Botanist, Zoologist, comparative Anatomist, and a most competent Physician, melted away under the influence of the damp and burning climate, and ended with the loss of the Captain, all the officers and scientific men. A similar termination closed the expedition of Major Peddie, for the discovery of the Niger.

The average mortality amongst the better classes in Sierra Leone, according to the testimony of Dr. Nichol, Deputy Inspec-

tor of Hospital, was formerly about one in twelve, or very nearly nine per cent.

According to Mr. Tiddie, acting Staff Surgeon at Cape Coast Castle in 1819, all the new-comers from England were seized with fever, and one-half died, more than one-third of the resident Europeans who had been there more than one year were seized with fever, and one-eighth died; in 1820 all the new-comers were seized with the fever, and one-half of them died, and of the older residents one-ninth died; in 1821 all the new-comers were seized with fever, and one-third died, whilst of the older residents near one-sixth died; thus making an average of one death out of every two and two-thirds, of the new-comers during the first twelve months after their arrival, and one death out of every eight of the resident Europeans who had been there more than one year.

From the Report of Dr. Barry, Deputy Inspector of Hospitals in 1822, we learn that twelve white sergeants from the Isle of Wight, selected as good and healthy men of regular habits, were attacked with fever, upon their arrival upon the coast of Africa, and within a few months after their arrival, eight paid the debt of nature, and the constitutions of three of the remaining four were permanently injured, whilst the sickness and mortality amongst their wives and children were nearly in the same proportion.

According to Mr. William Ferguson, Surgeon to the Royal African Colonial Corps, in the third quarter of 1824, the mean strength of British soldiers at Sierra Leone, was 585, of this number 386 were attacked with this African climate fever; 161 died, showing one death to 3.63 of the strength, and one death to 2.59 cases treated; at Gambia during the same period, the strength was 108, cases of Malarial fever 92, deaths 74, giving a proportion of 1 death to 1.45 of the original strength, and 1 death to 1.24 of the cases treated; at the Isles de Los, during the same period the mean strength was 103, cases of Malarial fever 99, deaths 23, showing 1 death in 4.47 of the strength, and 1 death in 4.3 of the cases treated. Captain W. F. Owen of the Royal Navy, in his attempt in 1827 to found a settlement at

Fernando, Po., lost almost his entire colony from the Endemic fever of Africa; and Colonel Nicholls who followed him in a similar attempt had one attack of Remittent fever, and eleven attacks of Intermittent fever, and lost twenty-five out of thirty individuals who composed the company.

Numerous other examples might be brought forward to show the dreadful effects of the climate of Africa upon foreigners, unprotected by the sulphate of quinia; we will, however, allude to but one more—the expedition of H. B. M. ships Wilberforce, Albert and Soudan, during the years 1841 and 1842, up the Niger with the leading object of promoting the abolition of the slave trade. When the expedition entered the Nun branch of the Niger, on the 13th of August, its complement of men and officers consisted of, officers including civilians and engineers 53, white seamen 63, marines and sappers 29, total number of whites 145; men of color entered in England 25, Kroomen and liberated Africans entered on the coast 110; blacks for model farm 23; total black 158; grand total 303. The health of the expedition continued good until the ships had proceeded two hundred and fifty miles from the mouth of the river, on the 4th of September, when a most malignant fever appeared in all the vessels, and spread with great rapidity. The first death took place on the 9th; and on the 17th there were 69 sick, 63 of whom were whites; and seven whites had died. The expedition was now so disabled that it was deemed advisable to send two of the ships back to sea; on the 19th the Soudan started for the mouth of the river with forty cases of fever, and was followed by the Wilberforce, with nearly an equal number of sick, on the 21st. The Albert continued up the river, the officers believing that the violence of the fever was in a measure exhausted, and that the climate of the more open country, higher up the Niger, would be found more healthy. The result proved otherwise. When the ship had arrived at Egga, 340 miles from the sea, not less than twenty more of the crew had been attacked, of whom two had died; and on the 3d of October there remained, capable of doing any duty, only one white seaman, the sergeant and one private

of marines, the geologist, the mate, one hospital attendant, and the surgeon, Dr. McWilliam: the entire enterprise was now abandoned, and the Albert steamed down the river to Fernando Po. Of the 145 whites who entered the Niger in good health, 130 were attacked with fever, and 42 died; of the 158 blacks, only 11 had the fever, and that in its mildest forms, and not one died.

The ratio of the men attacked by fever in the Albert was 1 in 1.127, the ratio of deaths in total number victualled was 1 in 2.696; and in the number of cases, 1 in 2.391; the ratio of the men attacked by fever in the Wilberforce was 1 in 1.666, ratio of deaths in number victualled, 1 in 8; ratio of deaths in number of cases, 1 in 6.857; the entire crew of the Soudan were attacked with fever; the ratio of deaths in total number victualled was 1 in 2.7.

We will now compare these facts and rates of mortality with the health of the British Squadron, employed for the suppression of the slave trade on the west coast of Africa, since the systematic employment of the Sulphate of Quinia as a prophylactic.

The observations which we will now present, are from the most reliable of all sources: the "Statistical Report of the Health of the Royal Navy," and we shall refer especially to the reports for 1856 and 1857, printed by the House of Commons, July, 1858, and August, 1859.

In 1856, the squadron employed for the suppression of the slave trade on the west coast of Africa, consisted of twenty-one vessels, with a mean force, including Kroomen and African boys, of 1630 men of all ranks and ratings. The number of men daily inefficient from wounds and sickness on the west coast of Africa, averaged about 55 per 1,000 of mean force.

The following summary taken from the nosological returns, will not only show that the great source of malarial fever in the squadron is exposure to effluvia or miasmata, while on shore, or in boats near the shore, or by the entrance of the cruisers into the large tidal rivers, but also that the great means of warding off the epidemic climate fever, and of moderating its

violence and duration, was the daily administration of the Sulphate of Quinia to the men during exposure to the noxious miasmata.

The Bloodhound remained during the entire year on the northern division of the station. In March she steamed about 300 miles up the Benue river; while in the river and for fourteen days afterwards, from three to six grains of the disulphate of Quinine were given to each of the ship's company as a preventive of fever, and although they were exposed to the emanations from the mangrove swamps for twenty-seven days, only six suffered slightly from fever.

Some time afterwards they were again exposed to miasmata in the Bonny, New Calabar, and in the Sherbro, the last one of the most dangerous rivers for Europeans on the whole station; but Quinine in solution was invariably used as a prophylactic, and with good effect, as only one case occurred after the vessel had been for a week in the Sherbro, and the patient was the only person who did not take the quinine regularly. No death occurred in this vessel from fever, but one man was invalidated for its sequela.

The Childers was employed almost constantly cruising, for the first six months of the year off the coast, in the Gulf of Guinea, and during the remaining months, off the coast, between Loango and Benguela. With the exception of a few unimportant cases, her crew entirely escaped fever, until three boats were sent on detached service up the Lagos River; in these there were twenty-seven white men and five officers. They remained absent for two nights, one of which was spent at anchor, off the town of Lagos. The surgeon accompanied the expedition and gave quinine-wine, which was continued after they returned on board: still notwithstanding, nine of the thirty-two persons who formed the party, were attacked with fever; two in five days after their return to the ship, one on the sixth day, one on the eighth, one the ninth, one on the thirteenth, two on the sixteenth, and one on the seventeenth. The disease in all was the same, differing only in its degree of intensity; some were convalescent on the eighth or ninth day, and others not before the twenty-eighth;

one had a jaundiced appearance. The surgeon thought the fever would have assumed a worse form, but for the quinine-wine which had been taken as a preventive. No other febrile disease of any consequence occurred in the Childers for several months subsequently, nor in fact until she had been for some time stationed on the southern division of the command, when four cases took place, after she had been eight days at anchor in the river Congo. The *Firefly* did not arrive on the station until August. Shortly afterwards she proceeded on a cruise off the river Pongas, while her boats, armed with white men, were sent up the river. They took Quinine wine night and morning while absent, and continued its use for ten days after they returned, and all escaped fever. Subsequently a few cases were contracted from long continued exposure to the miasmatic exhalations in the river Lagos. Eighteen cases of remitting and fourteen of intermitting fever occurred in the *Hecate*—the majority of the former were contracted on shore; two ended in death. The subject of one of the latter was a marine, who accidentally drifted away in the life-boat over the bar at Lagos; slept one night on shore, and was not attacked until fourteen days afterwards. In the other case, the patient, an officer, slept two nights on shore, and exposed himself to the full glare of the sun during the day time, by rowing about in a boat, without an awning, in the lagoon off Lagos; he declined taking Quinine as a preventive, and was attacked about fourteen days after he returned on board.

The *Merlin* arrived on the station about the middle of July, and after cruising a short while off the rivers Nunez and Congas, proceeded to the Bight of Biafra. She was then ordered on special service up the rivers Bonny, New Calabar and Brass; while thus employed, the following precautionary measures were adopted against fever: The crew were turned up at 5.30 A. M., after dressing, took half a wineglassfull of quinine wine; they breakfasted at 6. The decks were washed with water (warm) from the boilers at 6.30; they took dinner at noon, and supped at 5 P. M. No white men were sent away in boats. Serge frocks and white trousers were worn during the day, and blanket dresses during the night. No water was allowed to be drawn

from alongside for any purpose whatever. Quinine wine was administered to the whole crew for fourteen days after leaving the rivers, in which they remained altogether twelve days. Whether it was owing to the above measures it is impossible to state, but no sickness of any kind followed the several expeditions into these notoriously unhealthy localities. Although twenty-three cases occurred in this vessel, only one out of the whole number was of a severe character, and it was the result of intemperance and exposure on shore on the Isles de Los. The records of the other vessels all substantiated the great value of Quinine as a prophylactic.

It thus appears, that in all these vessels, with a mean force of about 1,680 men, there were only seven deaths from fever, being in the ratio of about a little more than four to the thousand, a mortality so small compared with that of former years, seems almost incredible, and might well lead to the belief that the coast, like some of the cleared portions of the North American Continent, is becoming more healthy; but, with the exception of the non-appearance of yellow fever, which does not depend on terrestrial emanations alone, the climate has undergone no salutary change.

The seemingly interminable forests which fringe the estuaries of every tidal river, are still as prolific of the fever poison as they were in times gone by, when the death-rate in the squadron was ten times greater. How then, it may be asked, are we to account for this improvement? Simply by the change which has taken place in the mode of conducting the duties of the station. By a wise and humane regulation, the deadly practice of sending boats away on detached service, to watch or intercept slaves, has been interdicted, or at all events, greatly restricted. Prize crews are no longer turned adrift to wander through the streets of Sierra Leone, when the vessels they navigate from distant parts of the station are delivered up to the authorities of the Mixed Commission Court; the orgies of 'the barn,' which lowered the character of the white man in the eyes of the black, have long since ceased; and last, though not least, the introduction of quinine wine as a preventive of fever has not only reduced the

number of febrile attacks, but has lessened the severity of those which do occur, and thus the mortality has also been reduced to a level which does not materially exceed the death-rate from fever on some of the more healthy stations.

There has also been a great change in the medical treatment of febrile disease: the so-called active measures which were in vogue but a few years since, have given place to others of a more rational character. Blood-letting is no longer carried to an extent which leaves the patient but little chance of recovery when the fever terminates, and the rash and empirical use of calomel in large and frequently repeated doses, to produce ptyalism, has been abandoned—not only on account of the impossibility of producing ptyalism while the fever lasts, but because mercury, given to excess in any form, has a most injurious effect on the constitution. If these changes have had no effect in reducing the mortality, they, at all events, have lessened the sufferings and misery entailed on patients, who though they survived the fever, lingered long in a state of debility from the effects of blood-letting and mercury.—*Statistical Report of the Health of the Royal Navy for the year 1856, ordered by the House of Commons to be printed 26th July, 1858: pp. 110–116.*

In 1857 there were nineteen vessels employed on the African station, with a mean force, corrected for time, of about 1620 men, including Kroomen and liberated Africans. The number daily ineffective from wounds and sickness averaged 112, or in the ratio of 69.3 to the 1,000 of mean force, which exceeds the ratio of the preceding year by seven. The total number of dead, exclusive of those lost by shipwreck, amounted to thirty-six—twenty-seven from disease, one from poison and eight from accidental causes; on the whole, therefore, the mortality was somewhat greater than in 1856. During the year, eleven cases of endemic fever terminated in death: the ratio per 1,000, 6.7, and although nearly a third greater than in 1856, it is still not greater than the mortality of some of the healthiest stations, and incomparably less than the mortality upon the African station, before the use of Quinine wine.

The following summary, taken from the medical journals of

the squadron, affords additional proof of the usefulness of Quinine as a prophylactic.

In the Trident there were forty cases of fever, but no death occurred: the greater number of these cases were contracted in the rivers which enter the sea in the Bight of Biafra. Quinine wine was freely used as a preventive. On two occasions when boats were sent up the Congo, the white men took quinine while in the river, and for fourteen days after they left it, and no fever of any consequence followed.

Fourteen cases occurred in the Sappho: they were nearly all contracted in boating expeditions up the river Congo. Quinine wine was administered to the men on these occasions, but several who did not take it regularly were attacked. Twenty men were employed off and on between the 30th of April and the 11th of May, on this service, watching a suspected vessel in the Congo. The medicated wine was administered carefully according to the printed circular. Only four men were attacked by fever, the disease showing itself about three weeks after they ceased taking the wine. In the Myrmidon and Pluto there were but few cases of fever, though they were employed on some of the most unhealthy places on the station: the former was laid on the beach at Sierra Leone, to be repaired, meanwhile her crew took up their abode in an old hulk which lay in the harbor. Some of the men, however, together with several of the Pluto's crew, were employed, both by day and night, as their work depended on the tide, in patching up the hull of the vessel. To these men quinine wine was administered twice daily, and the executive officers took care that they did not straggle into the town or bush; consequently no case of serious illness followed.

The gig and pinnace of the Alecto, manned by fourteen white men and six Kroomen, were sent about 150 miles up the Congo, late in December, with presents for one of the petty chiefs; they returned on the 6th of January, and between the 12th and the 18th every white man, with two exceptions, was attacked with fever. The same boats were again sent up the river to the same place on the 14th, when the two persons who had escaped fever formerly were now attacked, though one of them was not

taken ill until thirty days afterwards. With the exception of these two persons the boat's crew on the second expedition were made up of Kroomen, who, as usual, entirely escaped. On these expeditions, an ounce of quinine wine was given to the white men daily during their absence from the ship; but it appears to have been discontinued on their return. In January the boats of this vessel were again detached to cruise in the Congo, but did not proceed more than 40 miles up the river. Quinine was given to the men during their absence and for 14 days after their return. The same precaution was adopted after any subsequent exposure to malaria in the river, and no case of fever followed. The Bloodhound was employed in January in the River Benin, and during July in the Congo; as long as she remained within these rivers, and for ten days afterwards, four grains of quinine in a quarter of a gill of rum, was administered to every white man on board. One case only resulted from these two expeditions; and in that instance, the person attacked had exposed himself in a most imprudent manner while shooting wild fowl amidst the slimy ooze in the mangrove thickets on the banks of the Benin; whether the patient took quinine as a preventive is not mentioned.

Three boats from the Childers went up the Congo, as far as Ponto da Linha, and were absent for several days; quinine was administered to the white men, and no fever resulted.

In May, two boats were sent from the Hecla up the river Nunez, and returned on the following day. Quinine wine was issued in the usual manner, and no febrile disease followed.

In July, the same vessel entered the Sherbro, and subsequently her boats, containing fifty-six seamen and marines, with the usual number of officers, ascended the river to the village Victoria—they returned the same evening and rejoined the vessel, which remained in the river for a few days longer. Quinine in rum (the quinine wine having been all used) was given to the crew while she remained in the river, and for fourteen days after she went to sea. "Eight cases of intermitting fever," the surgeon remarks, "were added to the list a few days after our departure; they were, however, all mild, and terminated favorably, after an

average of seven days' treatment. To the regular and timely administration of quinine, I think our immunity from fever may be fairly ascribed; the cases that did occur were no doubt modified by the prophylactic. That this was the case, the mortality amongst the crews of the merchant shipping frequenting the river, and by whom no preventive is used, bears ample testimony."

On the 23 of May, three officers landed at Lagos from the Hecla, intending to return on board the following morning; but, as frequently happens on this coast, the surf rose suddenly, and continued so long, that they could not return to the vessel until the 29th. Again, on the 2d of August, the pinnace, with seven white men in it, was detached, to cruise in-shore between Little Popoe and Whydah, where she remained until the 8th. Quinine was given on both these occasions, and no fever resulted. On the evening of the 27th of November, the same boat and a gig, with nine white men on board, were left off Shark's Point, to guard the entrance to the Congo. An ounce of quinine wine was given to the men each morning. The boats remained in the same position until the morning of 30th, when they took advantage of a sea breeze, and proceeded up the river to Ponto da Linha. The gig, with one officer and two white men, returned on the 2d, and the other boat on the 5th of December. During their absence they had fine weather, and all returned apparently in good health. Quinine was now substituted for the quinine wine; four grains were given daily to each person at seven in the morning; but, notwithstanding this, nine out of the eleven were attacked by remitting fever.

The Merlin, between the 1st of January and the 30th of September entered the rivers Calabar and Cameroons, in the Bight of Biafra; she also entered the Nunez several times while on the northern division of the station. During the time she was in these rivers, and for some time after she had left them, quinine wine was duly administered to the white men on board, and no febrile disease of much importance took place; but in November, after having entered the Nunez and Pongas for the purpose of communicating with the native chiefs, her crew suffered most

severely from remitting fever. Quinine wine was given to the crew for some time, but the supply being exhausted, quinine in rum was substituted. When the change took place is not specified; but in connexion with the substitution of quinine purchased on the coast, and issued in the same manner in the Hecla, the quality of the alkaloid in both instances may be doubted. The Myrmidon was employed in the River Bonny, and afterwards lay a long time in Clearance Cove, Fernando Po; during the entire period quinine wine was given in the prescribed form; only one slight case of climatorial fever occurred. At Sierra Leone, while the vessel was under repairs, the whole crew took quinine once a day, and those who were engaged on the shore, twice; still though the latter were at work night and day, only one case of remitting fever resulted. In the same manner, the Pluto was laid in the beach at Sierra Leone early in March for repairs. The carpenters, together with the carpenters of the Hecla, and a number of blue-jackets who were employed on her, took the prescribed measure of quinine wine before going to work, and on leaving off; but the men who remained on the hulk took one measure only every morning until the 28th. Two men who had not been out of the ship were subsequently attacked with fever, but so long after the vessel had gone to sea, that the disease can hardly be ascribed to miasmata from the land at Sierra Leone.

It is worthy of notice that in the preceding instances, when quinine wine was administered according to the instructions issued with it, no fever of any consequence followed exposure to land or swamp miasmata; but on two occasions, when quinine purchased on the coast was substituted, and once when the wine was suddenly discontinued after the exposure, a considerable number of men were attacked, owing, it is to be supposed, to the discontinuance of the quinine wine in one instance, and to its bad quality in the other, for it is well known that, like other high priced remedies, it does not escape adulteration when it falls into the hands of dishonest traders.—*Statistical Report of the Health of the Royal Navy, for the year 1857. Ordered by the House of Commons to be printed, 2d August, 1859, pp. 78-85.*

A comparison of these facts with the great sickness and mortality of the white explorers and residents and sailors of the African coast and rivers, demonstrates conclusively:

1st. Quinine taken during exposure to the exhalations of miasmatic regions will, in most cases, ward off fever entirely.

2d. If fever attacks those to whom the quinine has been regularly administered, its severity and duration will be far less than in those who have not taken the quinine; it therefore not merely wards off disease but renders it less powerful and destructive when present.

3d. To be entirely efficient the quinine must be administered for some time, at least ten days, after exposure to the causes of fever.—*Southern Medical and Surgical Journal, Augusta, Ga., August, 1861, vol. xvii., No. 8, pp. 593-614.*

The observations which I have been able to make during the present war have confirmed the accuracy of the preceding statements; and I am convinced that the health and efficiency of the troops in certain malarious localities of the Confederacy would have been greatly promoted by the daily use of Quinine in the manner recommended. The value of Quinine as a prophylactic in preserving the efficiency of troops serving in damp, unhealthy, malarious regions, may be readily demonstrated by a direct calculation.

The following table illustrating the numerical relations of malarial fever to the other diseases, and its effect in reducing the strength of the command serving at Fort Jackson and the surrounding river batteries, situated in the low rice lands of the Savannah River, will furnish sufficient data for the calculation.

Cases of Malarial Fever, and of all Diseases occurring during a period of fifteen Months, October, 1862, to January, 1864, in the Command serving in and around Fort Jackson, on the Savannah River.

MONTH AND YEAR	Convalescent from Malarial Fever	Convalescent from Typhoid Fever	Convalescent from Dysentery	Convalescent from Cholera	Convalescent from Smallpox	Convalescent from Measles	Convalescent from Whooping Cough	Convalescent from Diphtheria	Convalescent from Scarlet Fever	Convalescent from Erysipelas	Convalescent from Tetanus	Convalescent from Rabies	Convalescent from Other Diseases	Total Cases	Total Deaths	Total Burials	Total Cases at all other Places	Total Deaths at all other Places	Total Burials at all other Places	Aggregate of all Cases	Aggregate of all Deaths	Aggregate of all Burials	Mean Strength of Command
October, 1862,	262	71	12	345	126	471	583	872															
November, "	67	24	5	96	44	146	218	315															
December, "	128	58	11	197	118	315	350	513															
January, 1863,	42	88	5	185	172	367	331	1144															
February, "	85	104	9	198	149	347	428	913															
March, "	78	132	33	246	143	389	458	913															
April, "	37	157	4	198	226	424	489	913															
May, "	62	76	2	140	184	324	360	878															
June, "	66	66	10	142	131	273	316	878															
July, "	77	177	67	321	187	458	504	878															
August, "	99	149	134	380	103	483	553	890															
September, "	149	127	134	410	98	508	588	822															
October, "	97	108	62	267	133	400	485	660															
November, "	1	47	54	22	124	60	184	255	789														
December, "	1	41	62	10	114	111	225	279	800														
Total	2	1355	1444	33	489	3313	1935	5218															

In an average command of 878 men, stationed at Fort Jackson, and the surrounding river batteries, nearly one-half, or 410, on an average were on the sick-list each month; and the new cases of malarial fever averaged each month 220. During this period of 15 months, 3313 cases of Malarial fever in the form of Congestive fevers, Quotidians, Tertians, Quartans and Remittents occurred; whilst all other diseases, including also those diseases, as Neuralgia, which might be traced in a measure to the action of malaria, numbered 1935 cases, or only a little more than one-half the number of the cases of malarial fever.

Throughout the entire period, more than one fourth of the command were unfit for duty; and during the fall months, more than one-half of the garrison was on an average incapable of performing military duty. In case of an attack during the sickliest season of the year, the effective force of the command instead of being 878, would be less than five hundred.

In using Quinine as a prophylactic in such a command, it would be necessary to administer the drug during at least five months; namely, June, July, August, September and October. If three grains of Quinine in a gill of whisky be administered daily to each soldier, we may safely estimate the amount of Quinine necessary to protect each man during these five months at about one ounce. This command of 878 men would, therefore, require for its protection annually about 878 ounces of Sulphate of Quinine.

During a period of 12 months, from October, 1862, to November, 1863, 2808 cases of malarial fever were treated; and if we allow 50 grains of Quinine as necessary on an average to the treatment of each case, very nearly 300 ounces of Quinine would be consumed in the treatment of these cases. It is important also to bear in mind that this amount of Quinine would in many cases produce only temporary relief, after the disease was once established, and would be powerless when thus occasionally used to prevent the serious lesions of the spleen, and liver; and the disease would be liable to return again upon the slightest exposure to the original cause, or to cold and damp, even in healthy regions.

It should be farther considered that the process of acclimation in the white race, is slow, if not altogether impossible in our southern swamps and rice-fields, and that an entire command might be gradually rendered unfit for service by the effects of malaria, in such a locality as Fort Jackson; and even after the men are removed to healthy regions, they are liable for many months and even for years to a recurrence of the various forms of malarial fever.

Amount of Quinine necessary to protect 878 men from Malarious diseases, during 12 months, 878 ounces, at an average cost of \$5 per ounce... \$4390 00
Amount of Quinine necessary to treat 2808 cases occurring amongst a command of 878 men, during 12 months, at an average cost of \$5 per ounce... 1500 00

Difference of cost of Quinine in protecting and treating these cases... \$2890 00

According this calculation, the Quinine necessary to protect the soldier from malarial fever, would cost two thousand eight

hundred and ninety dollars more than that assumed to be necessary to treat the cases of fever arising where no Quinine had been used as a prophylactic. We must, however, introduce into this calculation the pay of the sick, officers and men, which may justly be considered as an unproductive expenditure. If we place the number of men constantly on the sick-list, and unfit for duty from malarial fever, at 100, which is far below the actual number, and if we rate them as privates alone, each month \$1100 would be expended in the payment of sick men, or \$13,200 would be annually expended without any return whatever to the Confederacy. If we add to this the pay of the sick officers, the sum would reach a much higher figure; but we desire merely to demonstrate the utility of the use of Quinine as a prophylactic, beyond all cavil, even as a mere matter of dollars and cents.

Unproductive pay of 100 men for 12 months, laboring under the various forms of malarial fever (\$10 per month for each man).....	\$13,200
Increased cost of Quinine for the protection of the entire command during 12 months.....	2,890
Difference in favor of the use of Quinine as a prophylactic.....	\$10,310

It should also be taken into the account that the expenses in food, nursing, hospital accommodations, other necessary medicines, and transportation for the sick, are greater than the expenses of the supplies of the well soldiers; and it would be just, even to consider that the expenditures for the sick are a total loss, for they certainly add nothing to the defence of the country, or the efficiency of the army. But leaving this entirely out of the calculation, we have demonstrated clearly that the use of Quinine as a prophylactic would be attended with an actual saving of expense, for in exposed malarious localities a less number of troops properly protected, could be made to perform more efficiently the duties of a much larger force. Surely the accomplishment of such a result is of value, in a contest in which we are opposed by a powerful enemy, who outnumbered us in the ratio of three to one, and who with almost exhaustless resources has his ports open to the commerce of the world.

The argument which might be urged on the score of humanity,

is even stronger than that based upon efficiency and economy.

We must believe that the preservation of our soldiers from acute diseases, as well as from chronic affections, with enlarged spleens, impoverished and watery blood, dropsies and innumerable nervous derangements, excites some interest and concern in the minds of their officers, as well as of their relatives and friends at home. The difficulties of importing Quinine at the present time, are without doubt numerous, but they are not greater, and are perhaps far less, than the difficulties of the importation of the more bulky articles of clothing and luxury, which has been carried on to such an extent as to drain the country of gold, and to seriously endanger the moral and financial condition of the Confederacy. With the large amount of cotton at the command of the people and of the Government, it would not be an impossibility to import a sufficient quantity of Quinine to protect the troops exposed to malaria.

Owing to the limited supply, Quinine has not, up to the present time, been used to any extent as a prophylactic in the Confederate Army, and in several instances where the attempt has been made to use it thus, it has failed to yield the most satisfactory results from its irregular and unsystematic employment. It appears that it is very difficult to induce soldiers to take Quinine in the state of powder. The proper mode would be to mix the Quinine with whisky, (a certain number of ounces to a barrel of whisky), and issue the medicated whisky at a certain hour, each day, in the presence of officers charged with the duty of seeing that each man took his dose. As a general rule soldiers will not refuse whisky even when it contains Quinine.

Several instances have come under my observation where Medical Officers serving in malarious localities have taken quinine daily as a prophylactic, and whilst almost the entire command have suffered with the various forms of malarial fever, they have escaped with impunity. Last summer and fall, during great changes from the Military Department of Georgia and South Carolina to Piedmont Virginia, and from thence back to Carolina and Georgia, and during considerable exposure to ma-

larious influence in localities like James Island, acknowledged to be sickly, I protected myself with Quinine.

Doctor J. N. Warren, Assistant Surgeon of the 25th Regiment South Carolina Volunteers, stationed on James Island, S. C., in compliance with a request which I made him during a visit to the camps on James Island in the month of April, 1863, selected 200 men, from the regiment, and administered four and a half grains of quinine to each man daily. This was continued regularly until the 1st of October, when Dr. Warren was transferred to Augusta. During this period amongst this body of men, only four cases of malarial fever, and one case of typhoid fever occurred. The remainder of the regiment between 300 and 400 men did not take quinine as a prophylactic, and the majority of these men were attacked by paroxysmal fever; and over three hundred cases of the various forms of paroxysmal fever, together with 23 cases of Typhoid fever and two deaths occurred amongst them. During the service of this Regiment at Battery Wagner the men who took quinine daily, bore the fatigue better, and resisted the deleterious effects of the climate and the foul air of the bomb-proofs better than those who did not thus use Quinine.

On the 30th of April 1862, Surgeon Octavius White of the Palmetto Battalion Light Artillery, was delegated by Gen. Ripley, then commanding 2nd Military Dist. Depart. S. Ca., "to examine into and report the health of the various encampments on James Island and in St. Andrews parish, and also to furnish information upon the prophylactic virtues of Quinine against country fever.

The following is the report of Surgeon White:

HEADQUARTERS PALMETTO BATTALION LIGHT ARTILLERY,
JAMES ISLAND, May 7, 1862.

To Brigadier General Ripley, Commanding:

GENERAL:—In obedience to your direction and in conformity with my duty, I respectfully state that I have carefully considered the subject of your order and herewith tender you the result of my deliberation and inquiries.

There are four batteries located at various points on Wappoo Cut, each of which are held by detachments from the Palmetto Batteries of Light Artillery. One of them is at Simons' Landing, one at Minott's Bluff, another at Heyward's, and a fourth at the mouth of a conduit to it, called Elliot's Cut.

The camping grounds around these batteries are surrounded by marshes, which are never flowed by salt water, except by the very highest tides. Abundance of fresh-water springs from either bank and the showers pour their contributions into them. Thus in many places stagnant pools of brackish water form. Such, according to Sir John Pringle's statement, develop animalcular life with wonderful rapidity, and perpetually undergo alternate decay and replenishment. That peculiar forms of fever, malignant in their type, and the morbid changes they impress upon the system and several organs of the body, should result from so free an elimination of malaria, is by no means surprising. The batteries at Heyward's and Simons' Landing are in St. Andrew's Parish, on the south-western shore of Wappoo Creek. The grounds around these batteries are particularly low, and consequently damp. St. Andrew's Parish has ever had the reputation of being the most unfriendly to the white man in the summer, within the limits of the State. So insidiously does the charming spring glide in, that planters in that vicinity have not unfrequently been lured to remain until driven off by some unmistakable warning, and the unhappy fate of some belated individual, has too sadly indicated the danger of delay. From such experiences as these, the 16th of May has generally been agreed upon as the latest date, when it is prudent to remain within its unwholesome precincts. The migration of residents in this section of country, takes place, therefore, with one accord, on or before that period.

The Batteries at Minott's Bluff and Elliot's Cut are on James Island. The grounds adjacent thereto, from their superior elevation, lighter and dryer soil, have every appearance of being healthier spots, and yet no prudent winter will venture to overstay the magic time. The period settled by experience to vacate the plantations on this island is much later than those in St. Andrew's Parish, by nearly one month. I learned from one planter that his brother remained one year with his family at the place known as Janton's until as late as the 27th of June. He immediately removed to Summerville, and shortly after paid the penalty of his rashness by not only being taken sick himself, but by having every member of his family prostrated with fever also.

Effectual drainage is universally acknowledged to be a matter of the greatest consequence in our climate. This no doubt is the reason that the health of so many malarious regions has been improved by railroads passing through them.

I deem it my duty here to notify you, that the natural drainage of the island, as well as of the main, has been seriously interfered with by the line of breastworks which have recently been thrown across the country. These obstructions will no doubt largely contribute towards rendering the neighborhood around them more sickly than ever this summer.

You are doubtless aware, Sir, that we are every day approaching nearer and still nearer the period in our climate so dreaded in these localities. Soldiers who would leap without a thought into the imminent breach, whose lips have never blanched before any other enemy, naturally quail at the bare thought of encountering so mysterious a foe. Fortunately, however, we are possessed of an efficient antidote, which if faithfully used and persevered in, will enable any to brave with safety the most serious exposure to this common enemy.

Of the prophylactic virtues of Quinine against malarial impressions, it may be asserted with confidence that fortified with that wonderful drug, none need fear vic-

tering at any time into the heart of our hostile low-lands in summer—inhaling with impunity its deadly miasm.

Abundance of evidence can be brought to prove this assertion. The experience of numerous overseers could be adduced to prove the statement. This reliance in its virtue to resist malarial diseases is unlimited. Many have lived protected by it for ten years, and more, spending summer after summer in the sickliest regions.

Dr. Barker and the Government summer after summer in the sickliest regions. Dr. Barker and the Government summer after summer in the sickliest regions. Dr. Barker and the Government summer after summer in the sickliest regions.

The African explorers under Dr. Livingstone, were preserved entirely free from the pernicious fevers of the climate, by the habitual use of quinine. Further evidence of the prophylactic virtues of quinine has also been afforded by many of the officers of the British Government stationed on the coast of Africa, in reports from their various stations collected and arranged by Dr. Alexander Bryson. The British Steamer, *Eliala*, steamed up the river Niger in July, ascended the river Chaddon and returned to England without the loss of a single man. All owing to the proper administration of Quinine. The party included sixty persons and the expedition was in the river one hundred and eight days; twice as long as the expedition of 1842, which unprovided with Quinine, ended in so fearful a loss of life. Surely no farther evidence can be needed to prove that the daily and proper use of Quinine in malarious regions is capable of so modifying the system as to render it capable of resisting the deleterious influence of climate, and of protecting individuals from either intermittent or remittent fevers.

The dose usually prescribed under such circumstances is from three to five grains, regularly taken every morning before breakfast. Each bottle as sold in the shops contains about one ounce (480 grains). This quantity, therefore, would be only sufficient for ninety-six men one day. All the companies of this battalion are over one hundred strong. Most having as many as one hundred and fifty men. The estimate, therefore, could be safely made that about eight ounces per diem would be needed to protect this battalion from the noxious influences to which they will be exposed, if compelled to remain upon the present camping grounds.

Should it, however, become impracticable to supply us with the necessary quantity, I respectfully suggest that immediate measures be taken to have the companies composing this battalion removed to Sullivan's Island, or some other healthy locality.

Though the summer months ordinarily present us with the first cases of country fever, it is not unusual for sudden heats of spring to develop cases as early as the middle of May. I have heard Prof. Dickson assert that he has known instances originated from special exposure as early as April. It is a fact moreover, as formidable as curious, that a malarial impression may be received and remain dormant in the system until roused into intense action by simple change to a healthier locality. Speculation is at a loss as to the obscure cause of such additional malignity being occasioned by a mere removal during what has been called the "latent period."

Experience, however, has established beyond a doubt, that such an attack is always attended with peculiar hazards and it is, therefore, thought advisable in every case after exposure to use strict precaution against the apprehended attack from seven to twenty-one days."

[Signed]

Your obedient servant,
O. WHITE, Surgeon Palmetto Battalion Lt. Art'y.

Surgeon Samuel Logan, Chief Surgeon of the 2nd and 3rd Military Districts, Department of South Carolina, Georgia and Florida, has recently contributed the following important facts upon the prophylactic powers of Quinine:

"The following table was compiled with the view of enabling the writer to arrive at some conclusion as to the prophylactic power of quinine. The items were collected, either by himself or the medical officer in charge, to whose cheerful co-operation he is much indebted. It will be observed that in no single camp was the agent unanimously adopted; in many, indeed, its use was resorted to by a minority only. So far as my object was concerned, this enables me to compare the results among those situated under the same identical circumstances in all particulars, except the use or neglect of the agent whose effect we are investigating. I would call attention to the fact, that much more importance should be attached to the results developed under these circumstances, than when the experiments are made with separate corps, all of whom either took or neglected to take the quinine as a prophylactic. I know of no statistical researches, except of my limited extent, in which this peculiarity obtains—in fact our statistical knowledge on the subject is extremely limited—and I therefore deem it of some importance to invite the attention of the profession to the table I have collected. All the troops from whom these items have been gathered, were stationed in the most highly malarious regions in the Confederacy.

With the exception of a few favored localities, the whole country has to be abandoned by its white inhabitants as the summer approaches. They usually resort to the pine lands or the sea-shore about the first of May, and return about the first of November.

The peculiar topography of our Southern Atlantic low-lands is well known, but may be briefly mentioned. The coast line is indented with numerous inlets, bays, and salt-water creeks, which form a complicated network extending from ten to twenty miles from the sea-shore proper. These creeks and estuaries are generally fringed with wide plains of salt marshes, except where the larger rivers freshen them and form the valuable fertile rice lands. The islands formed by this network of water-courses are, with the exception of the marshes, composed of a light sandy soil, in which the stratum of clay lies from three to six or eight feet below the surface. They were devoted to the culture of the famous "sea-island," or long-staple cotton. As we come more towards the interior, and especially near the larger streams, this light sea-island soil more or less disappears, and we have level tracts of a stiffer earth, occasionally sandy, but in most cases having a structure of red clay, either near or quite up to the surface. The undergrowth is here extremely luxuriant, and reminds one of the pictures of African jungles. The country is intersected with swamps, some of them cultivated in rice and presenting a considerable alluvial deposit upon a bed of blue clay.

Next to this belt of "low-lands," we come to the pine-regions, a dry and porous sandy soil, with clay of a considerable depth, the sand in the higher localities being of a bright yellow or white, and in the lower ones dark grey. This flat belt of "pine barrens" gradually changes into the rolling country of the interior, and so on up to the mountain slopes.

The malarial fevers prevail throughout the sea-islands, with a few exceptions; through the whole belt of level low-lands, and to a considerable extent in the lower of the pine lands. The higher portions of the latter, and certain favorable localities along the sea-shore, and among the sea-islands, are more or less exempt and are resorted to during the summer months. The enemy have occupied almost all of the healthy sea-shore, while our lines of defence extend through the sickly low-lands, just within the belt of sea-islands. In order to promote the health of the troops, such of them as are located along the lines in the neighborhood of healthy pine land resorts are moved in the summer months to such places. Those commands, however, who do the picket duty, even though their summer camps be pitched in a healthy pine-land village, are still subjected to malarial influences while on this out-post duty along the line, day and night, at an average of about one-third or one-fourth of the time. Those commands, who were, as a general rule, retained during the summer in their healthy resorts, were not provided with quinine to use as a prophylactic, and have not, therefore, been made the subjects of investigation. They had little or no fever among them; while those whom it was necessary, for strategical purposes, to retain in the unhealthy country, and the cavalry who did picket duty in sickly localities, were provided; and a reference to the table will show to what an extent each command availed itself of the agent, and what were the results.

In some cases the Quinine was taken in the morning, in others at night, four grains being the quantity used. Some of the medical officers believed beforehand in its efficacy; others held their opinions in suspense, while a few disbelieved in its use as a prophylactic. I was among those who were not inclined to form a definite opinion until a larger mass of evidence had been collected in such a manner as to show the comparative results among those placed under identical circumstances, in all particulars, excepting the use of the agent. It will be well to make a few remarks concerning the different corps and their precise localities.

1st. *The Rutledge Mounted Riflemen and Horse Artillery* did picket duty along the line between the Coosahatchie and the Combahee rivers, a section of country of an undoubted malarious character. They were encamped in a tolerably healthy pine-land village, McPhersonville, three and a half miles from the Pocotaligo station, on the C. and S. R. R.

2d. *Captain Ford's Battery* was stationed during the summer of 1862, on James Island, near Charleston, S. C., (a location of notoriously bad reputation for health) until September, when it was moved to a position about six miles below the Hardeeville station, on the C. and S. R. R., not far from the Savannah River. They gained nothing from the change so far as a healthy camp was concerned. The next summer they were stationed near the Green Pond station, between the Combahee and Ashepoo rivers. This also is a highly malarious location.

3d. *Company I, Third S. C. C.*, as I am informed by Dr. W. M. Bailey who has charge of them, was stationed in the interior of Wadmalaw Island, a situation, from the evidence of the physician who practiced there before the war, exceedingly unhealthy as regards fevers, in the midst of swampy lands and numerous stagnant ponds.

About four grains of quinine were given each day at retreat; in which quantity it was administered from the 1st July until 1st October.

Dr. Bailey goes on to say that not being supplied with a sufficient amount of the

article he continued, from that date, to administer it in reduced doses of two grains until about the 15th of October. Whether from the effect of climate, or from the reduced quantity given, I had at this time many more cases of fever.

4th. *Company B., 6th Regiment S. C. C.*, was stationed near the river bank of the Edisto, a situation personally known to me as very unhealthy. With them also the quinine was reduced from October 1st, from four to two grains, and stopped on the 15th.

5th. *Company D., 5th Regiment S. C. C.*, arrived at its camp near the Combahee river on the 27th, September, having been stationed in Charleston during the mid-summer. The men were exposed on picket in a very malarious country, at the most unhealthy season, but captain L. Davis, in command, immediately commenced to issue four grains of quinine in a wineglass of whisky every morning at reveille, and continued it until frost.

6th. *Blake's Battery* was stationed during the whole summer on James Island. They moved camp three times, but were always located in positions which Assistant Surgeon Mallory C. Rives in charge—who has kindly furnished me with the details—knows to have been unhealthy, from his intimate acquaintance with the facts before the war. The quantity of quinine issued was, as in the other cases, four grains daily.

7th. *Kirk's Partisan Rangers* and the five companies of the 4th S. C. C., were situated in all respects as the Rutledge Mounted Riflemen, and had the same duty to perform. They also took the same quantity of quinine.

8th. *The Washington Artillery* spent the summer in a very malarious location, amid the swamps between the Edisto and Ashepoo rivers. Assistant Surgeon W. S. Canine writes that on the 1st of July, 1863, the administration of quinine was commenced in four grain doses every night, and continued until the 12th of November.

I have only to remark in conclusion, that in no case has any cumulative effect been observed to follow the continued use of quinine.

It would seem from these statistics that, though not an absolute prophylactic, the degree of protective power possessed by the agent fully warrants its use. If four-fifths of the fever cases are prevented, it should surely be used.

It may be well to explain that under the head of "number who took Quinine irregularly," are included those who would forget or neglect to take it some three or four days in the week, or take it one day and forget it the next, or omit it for a week at a time.

CONSOLIDATED TABLE OF CASES.

Total number who took no Quinine, 230; had fever, 134; ratio per 1000 of fever cases to patients, 582.60, or 1 in every 1.71 patients; ratio per 1000 of severe cases to total cases, 313.43, or 1 in every 3.19 cases.

Total number who took Quinine irregularly, 246; had fever, 96; ratio per 1000 of fever cases to patients, 390.24, or 1 in every 2.56 patients; ratio per 1000 of severe cases to total cases, 291.66, or 1 in every 3.71 cases.

Total number who took Quinine regularly, 506; had fever, 98; ratio per 1000 of fever cases to patients, 193.67, or 1 in every 5.16 patients; ratio per 1000 of severe cases to total cases, 326.58, or 1 in every 3.06 cases.

NASHVILLE, TENN., May 10, 1867.

PROF. JOSEPH JONES, M.D.—DEAR SIR:—In compliance with your late request, I submit the following cases as having come under my observation as to the prophylactic powers of Quinine.

CASE 1.—In the year 1847 a clergyman, assigned to mission duty in the coast districts of South Carolina, reported to me that for a number of summers previous he had suffered from very severe bilious attacks, of a congestive character. I saw him just before entering upon his next mission. I advised him to follow this prescribed course: the occasional use of Blue Pill and to take daily for some weeks from four to six grains of Quinine. Then to intermit for some two weeks, and repeat as previously ordered. The result was a perfect immunity from his accustomed attacks.

CASE 2.—A medical friend of Wilmington, N. C., informed me that his brother, a distinguished politician and lawyer, whose business and repeated canvasses subjected him to attacks of malarial fever in the coast counties of North Carolina, had been advised to a like course of treatment. The prophylactic powers were complete.

CASES 3, 4, 5, and 6.—Two rice planters on the Cape Fear River, North Carolina, who daily exposed themselves in superintending their planting and culture interests, suffered very severely from bilious attacks, were advised to a like course. They invariably escaped when instructions were rigidly followed. And two overseers in the rice farms of the same river were in a like manner shielded. I repeatedly met these parties, and at the close of harvesting, and never saw better specimens of men in perfect health.

The cases of negroes who were slow to become acclimated and who were greatly exposed and had repeated malarial attacks, were most generally thoroughly protected, might be put down by scores and hundreds. With the latter, the Pil. Cath. Comp., as an adjuvant to the Quinia was most generally used—p. 2. n.

Between seven and eight years I practiced medicine in Wilmington, N. C., in the rice bottoms and upon the adjacent salt-water coast. I can testify that the exceptions were but few to the success of this prophylactic treatment when systematically observed.

Most truly,

D. DU PRÉ, M.D.

THIRD EDITION.

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OBSERVATIONS

UPON THE

PRESERVATION OF MEAT, POULTRY, AND FISH,

AND OTHER FOOD PRODUCTS.

Something like two hundred patents have been taken out in this country for the "Preservation of Food," many of them, indeed, within the last few years; but, as is very well known, with the exception of some specially intended for preserving fruit and vegetables, there has hitherto been no really efficient and reliable process by which the decomposition or decay of food products in general could be prevented. It is true that taking the subject as a whole, numerous and important improvements have been made; in the manufacture of ice and refrigerating machines; in the modes of pickling or salting meat; in the compressing and sealing in tins, of various preparations, &c. &c.; but all these contrivances, even when most successfully carried out, present some objections which are fatal to their general use; they are either injurious to the flavour, or destructive to the nutritive value of the substances intended to be preserved; the processes themselves are too complicated in their action, or too uncertain in the results obtained; or, lastly, the cost of the preserved substance is such that it is useful only in an auxiliary sense, and is utterly inapplicable to the every-day requirements of the people at large.

There are but few among us who will not readily acknowledge that a large quantity of good and wholesome food is annually lost to us, simply because it "will not keep fresh" for a sufficient time; but the reader may perhaps hardly be prepared to hear that from eighty to one hundred thousand tons of animal food is year by year wasted and destroyed in Great Britain, even when there is no epidemic prevalent amongst our live stock.

Let us reflect for a moment upon the significant fact, that while the cattle plague has lost to the country from the commencement of its invasion, about 44,000 tons of meat, fully twice that quantity of animal food is annually wasted for the want of a certain, simple, and inexpensive method of preserving it. It follows, therefore, that the subject we are thus briefly considering is of no trifling character, and that a process possessing the features just indicated, must prove of the greatest interest to all of us individually, while its general and social importance can hardly be over estimated.

Such a process has just been discovered, and under the formal official heading of "Letters Patent granted to HENRY MEDLOCK and WILLIAM BAILEY for Preserving Animal Substances," we find some details which are capable of such extended and universal application, that in years to come, from the arctic circle to the tropics, not a single pound of animal food need be lost to the use of man. By a few minutes' labour, and at a trifling outlay, anything of animal origin—from a beefsteak to a bullock; from a whitebait, to a whale—can now be preserved sweet, wholesome, and uncontaminated, for days, weeks, or months if necessary, wholly irrespective of country, climate, or time of year.

Being fully aware of the prejudice hitherto existing against preserved animal food, we beg to offer a few practical suggestions that may perhaps induce the public to modify their opinions on this important and national subject.

In the first place, it will be as well to consider briefly the chief causes of failure hitherto in the preservation of meat, fish, poultry, &c. speaking, of course, in a practical and commercial, not a scientific point of view, as it is well known that many operations can be successfully performed in the chemist's laboratory which are far too difficult and expensive to be carried out upon a large scale. We may dismiss the preservation of food products by means of ice or freezing mixtures, in a word, as they are evidently capable of very limited application. Some of our large butchers, fishmongers, &c. keep their goods in ice cellars during the hottest seasons; but this practice is quite exceptional, and probably not one per cent. of the dealers in such perishable articles have the means of keeping them moderately cool in summer. Even in these instances the advantages to the public are considerably modified by the fact that frozen animal food, when exposed to warm temperature,

will putrify with very great rapidity. According to Dr. Cattell, animal food, and more especially fish, is always rendered less nutritious by the freezing process, and is frequently injurious to health.

Of the other methods of preserving animal food that call for a passing notice the salting or curing plan must of necessity rank foremost, as it has been in use for centuries, and, to a moderate extent, is convenient, popular, and beneficial. Salt, however, is powerless to preserve meat effectually in any but the coldest weather, unless so large a quantity is employed that substances thus treated are both unpleasant to the palate, and dangerous to the gastric functions.

Our present limits entirely forbid a dissertation upon the physiological action of salt when large quantities are taken internally; suffice it that in excess salt is very injurious, and that innocent as it is popularly believed to be, more than one case of "poisoning" by its use, has been recorded by Dr. Christison, and others. Another and a grave disadvantage attending the use of salt is, that meat loses from one quarter to nearly half of its nutritive value in the usual salting processes, and is almost entirely robbed of those mineral constituents, more particularly potash, the want of which induces scurvy and other diseases.*

Of the dried, powdered, compressed, or extracted meats we need say but little; their applications are so extremely limited that it is out of the question to consider them in relation to the broad subject of food for the people. For travellers, invalids, children, &c. they are frequently of service in the absence of more rational food, but their cost is always treble or quadruple that of the more common, but practically wholesome beef and mutton.

Lastly, we must notice the meats put up in hermetically-sealed tin canisters, either with or without the addition of salt, spices, or antiseptics. It cannot be denied that these preparations have proved of great utility to our soldiers, sailors, and explorers, as a change from the "odious salt meats," and that they have exercised a marked influence upon the health, comfort, and general physique of these classes of our country.

* Dr. Marcet's plan of enclosing the meat in bladder, or some similar material, before immersing it in the brine, by no means obviates these objections, although, to a certain extent, an improvement upon the old method.

men during the last twenty years; but we have still to reiterate the same fatal drawbacks to their general use, namely, uncertainty,* want of flavour and nutrition, costliness, and, in many cases, a very unpleasant metallic taste derived from the containing vessel. Besides these special disadvantages which vary with each particular process, there is another, and a serious one, common to all the preserved meats of this class:—They are, without exception, prepared at a temperature considerably above the boiling point of water, and are, consequently, much over-cooked in the first instance.

Similar objections, in a greater or less degree, apply also to those preparations which are merely coated with a thin film of some substance, which is air and waterproof, such as wax, paraffin, collodion, gutta-percha, &c.; while if the protecting envelope of these last is broken or punctured at any one point, however small, decomposition sets in immediately.

With the difficulties at which we have thus cursorily glanced, in the way of the successful conservation of animal food, it is not to be wondered at that new suggestions on the subject are received a little dubiously; in the present instance, however, so many of the old disadvantages are disposed of at the outset, that the reader's earnest attention may be claimed with confidence.

Messrs. MEDLOCK and BAILEY's process for the preservation of animal substances possesses manifold advantages over all others hitherto proposed, but more especially those of economy, and simplicity of application. By its means the meat, poultry, game, fish, &c. of a large household, or wholesale establishment, can be effectively preserved for months in any weather, at a nominal expenditure of time and money; no soldered tin cases are required, no complex apparatus is necessary, no want of flavour or nutritive power is the result; and, finally, whether the edibles thus treated are eaten in two days' or two months' time, nobody, save the actual manipulator, need know anything about it.

How is all this to be accomplished? Let the reply be in terms that may also serve as "directions for use."

* By "uncertainty" we mean that when once a tin of "preserved meat" is soldered down, no person can tell what it is, or in what condition it may be. Many of these tins are wrongly labelled, and our readers will remember that in 1851 (out of one particular batch only), of 6,000 tins of preserved meat supplied under contract to Government, and opened, more than 5,000 contained putrid meat and offal!

In the case, say of a small family who wish to keep a leg of mutton, or a sirloin of beef, for a week in sultry, thundery weather, with the thermometer at 90°, take a teaspoonful of "MEDLOCK AND BAILEY'S PATENT BISULPHITE OF LIME SOLUTION," a dessert spoonful of common salt, and about a quart of cold water, mixing the same in an earthen pan, basin, or other suitable vessel. Dip the meat in this mixture for a few minutes, taking care with the end of a cloth to WET IT ALL OVER, then hang the joint up as usual. A dip, night and morning, will ensure its keeping sweet and fresh for any length of time. If the weather is unusually hot, a cloth soaked in the same solution may be wrapped round it with advantage.

Can anything be easier than this?

Game, or poultry, may be treated in precisely the same manner, having been first plucked and drawn. Fish, too, should be previously gutted. Eggs may be retained in the fresh or "new-laid" condition, simply by being completely covered over with bran soaked with the same liquid mixture; while bacon can be prevented from getting "rusty" by this simple plan, which of course can be readily modified to suit different articles of food. If the joints are large and numerous the proportions should be thus:—

Bisulphite of Lime	2 quarts.
Common Salt	1 pint.
Water	4 gallons.

When the meat, &c. is required for cooking, all that is necessary is to lay it in cold water for a few minutes, and afterwards to dry it thoroughly in a cloth; on a close inspection no odour or other alteration whatever will be apparent—the lean will not be reddened, nor the fat changed to the deep yellow tint so often apparent with "hung" meat, and the texture will be, as at first, firm and consistent. Nay, more, if not content with the evidence of our ordinary senses, we place a portion under the microscope, we shall observe that the general structure of the tissues has not suffered in the slightest degree; and if we went further, and delivered the whole to an analyst,* his report would be that the various nutritious principles were present as usual, and had not sustained the slightest injury.

* See Analytical Report at page 16.

With the view of testing the effects of this new preservative, in tropical climates, some beef, mutton, fowls, salmon, lobsters, &c. were treated by MEDLOCK and BAILEY'S patent process, and exposed in a chamber specially arranged for the purpose, to a temperature varying from 80° to 110° F. Portions of the same joints, fowls, &c. not prepared in any way, began to emit an unpleasant odour in about 16 hours, and were absolutely putrid in 12 more, while those treated with the preservative mixture showed no sign of decay whatever during the whole period of twelve days; from the very high temperature to which they were subjected, a little oily matter, separated from the fish, but the original odour and flavour remained unimpaired to the end of the time; even the lobsters being pronounced "delicious, evidently just boiled" by those who partook of the same. The eggs which had not been treated with the bisulphite, &c. all more or less decomposed under the influence of the heat, while the others remained "new-laid" throughout. In a word, these experiments, intended to test, in the most severe manner, animal food treated with bisulphite of lime, at a tropical temperature, simply afforded still further evidence of the great practical utility of this invention.

At the time at which we write, some three months since the trials we have just recorded, all the meats, fowls, &c. remaining unseasoned are perfectly good and sweet, although exposed to the ordinary changes of temperature, &c. in a rather warm room.

Now, what do these experiments teach?

Firstly, in our own, or a similar climate, we see at once that families and tradesmen need no longer suffer in health and pocket from the effects of sudden heat or close damp weather; there will be no further occasion for butchers either to sell their meat a few hours after it is killed, and while in that essentially unwholesome and very unpopular condition known as "hard, tough, and indigestible," or, having had to throw away, as "tainted," perhaps 60 or 70 joints in one night, to charge an extra profit for what remains, to cover losses, as is now very frequently the case.* Then, again, it is stated by a well-known

* We have very often conversed with butchers on this point; and one of our metropolitan dealers asserted us he had caused upwards of a ton of meat to be thrown into the Thames within two days, while another asserted his annual losses to be over 8 tons.

authority, Mr. Wentworth L. Scott, F.C.S.* that of the meat supplied to London nearly ten per cent. (9·5) is unfit for consumption on account of its being putrid, or adulterated in one way or another. Now, London annually consumes at the present day (according to the above authority) something like 200,000 tons of meat properly so called—irrespective of fish, poultry, &c.; even cutting down this estimate, which we believe to be a low one, to three quarters, this would give 14,250 tons of diseased or putrifying meat, which is disposed of to the poor in low neighbourhoods, principally at night. Some 14 years ago a very competent authority—Mr. Harper—speaking upon this subject, said "There is one shop alone doing £500 a week regularly in diseased meat," which, at the low price it was sold at, would give but little short of 3,000 tons per annum for this single establishment only.

The last report of the Medical Officer of Health for the City of London shows that upwards of 152 tons of meat were condemned in 1866, on account of putridity, &c. by the market inspectors, in addition to "1,126 head of game and poultry, 8 quarters of venison, and many tons of fish and shell-fish." Now this quantity cannot be referred either to the entire metropolis with its population of over 3,000,000, nor merely to the "city of London" proper, with its area of less than a square mile, and only about 114,000 inhabitants; consequently the return is of little statistical value, as it only represents the amount of meat unfit for consumption, which came under the notice of the inspectors in the markets of Newgate, Aldgate, and Leadenhall,—perhaps a hundredth part of the total bad meat of the Metropolis in 1866, irrespective of the further large quantity which gets "sour" or "tainted" in private households, and is wasted there. From some returns, obtained through the Worshipful Fishmongers' Company, we learn that 1,370,287 fish, weighing something over 191 tons, were seized last year; of the far greater quantities which escape detection or become unwholesome from keeping in the hands of retailers, we can, of course, get no reliable details. It is needless to observe that London does not stand alone in the matter of meat wasted, because we have had no means of keeping

* "On Food; its Adulterations, and the Methods of Detecting them."

it fresh and wholesome. Large quantities of animal food are condemned in nearly all parts of the country.

In Liverpool, the following table exhibits the weight of meat and fish, and number of shell-fish destroyed during 1866, as unfit for human consumption.

MEAT AND FISH CONDEMNED AND DESTROYED AT LIVERPOOL, 1866.

(EXTRACTED OFFICIALLY FROM THE CORPORATION BOOKS.)

Beef	110,585 lbs.
Veal	18,609 "
Mutton	10,846 "
Lamb	316 "
Pork	27,809 "
Total Meat	163,165 "
Fish.....	190,630 "
Shell-fish	125 fish.
Oysters	2,600 "

Or a total of about 161 tons, being more than a pound and a quarter of animal food per head of the population known to be wasted, in the first instance, at the markets only; and to this return we have to add 1,083 head of poultry, and 2,667 rabbits and hares. The Manchester returns of condemned animal food seem to be less exact, the amount seized in a year being however very considerable, while in Bristol, we only hear of about "4 cwt. of beef and mutton, 3 cwt. of beef and 5 carcasses of mutton (say 1,200 lbs.)" having been seized in two years by the "Inspector of Nuisances."

In Birmingham 19,015 lbs. of meat, 2,434 lbs. of fish, 124 hares and rabbits, besides poultry, have been condemned during the year 1866, and in Wolverhampton many cases of "seizure of bad meat" have occurred during the setting up of these pages.

These facts, incomplete as they are, sufficiently show that the chief requirement of the country in relation to food, is undoubtedly a good practical and economical method of preventing meat, &c. from "tainting" or "going bad," even for a day or two.

* Calculated upon "Liverpool Parish" only.

This can now be readily accomplished under Messrs. MEDLOCK and BAILLY'S Patent. What can be more simple, for example, than for a butcher to sprinkle his joints with a little of the solution; or for a fishmonger to fill his watering pot with the same liquid, allowing it to fall in little rills over the soles and salmon, lobsters or cod fish, exhibited upon his marble slope? thus enabling flesh, fish, and fowl alike to remain a sufficient period before cooking, and attain their full perfection of tenderness and flavour. In the case of country slaughtered meat, sent to London from a distance of say 600 miles by rail, the advantages resulting from the use of this magnificent preparation will be equally apparent; there need be no more "offensive railway stations," no further complaint of the "20 per cent. loss per journey in summer," and, in these days of "tender teeth," more important than all to many people, no more "tough beef, only just killed, on account of the heat."

Again, although want of space forbids our entering here upon the relative merits of the "live" and "dead" meat supplies of London, or any other place of magnitude, we cannot refrain from offering a few broad, general observations.

It is well known that a very large quantity of meat is sent to London in the shape of "carcases," or entire animals, which have been killed in Aberdeen, Devonshire, Lincolnshire, Wales, or elsewhere, and instantly despatched to the metropolis. The amount is, of course, very variable, being modified by circumstances, the weather being by no means the least important. At the present time the annual quantity supplied in this way may fairly be taken as not less than 160,000,000, to 170,000,000 lbs.

Now, if anything should happen to any portion of this meat while on its way—say from a change in the weather—contact with, or proximity to manure, or other offensive matter,* or from accidental detention even—what is the consequence? Why, that every pound of the previously wholesome animal food so "tainted," must either be destroyed on its arrival, or is sold for next to nothing, and thus permitted to engender or develop disease in various forms among the "half-starved poor of London."

Now, we shall be enabled to "change all this;" for if the country slaughterman avails himself of this patent process, and either dips his meat in the solution of Bisulphite, or sprinkles the latter over it, before packing, every ounce will arrive fresh and sweet at its destination.

* We have known several instances of meat spoiled in this manner during transit.

in spite of delay, weather, or even flies. A second, rapid application by the city carcase-butcher, or meat salesman, will ensure the perfect "sweetness" of his beef and mutton when cut up.

As a mere money-saving only, the advantages to be thus derived, are self-evident, for on the item of ice alone many thousands of pounds are annually spent in the endeavour to keep meat, &c. fresh by the use of this most costly article; we have been assured by a salesman, well known in Leadenhall Market, that his expenses for ice at the present time amount to upwards of two guineas a week.

Taking a wider field, will the reader imagine for one moment the sensation which tender, sweet, "hung" meat would produce at Cairo or Calcutta?

At the former place, for instance, we know upon undeniable authority that the meat there killed in the morning must be eaten before night, as if allowed to remain even a few hours after sunset it speedily becomes putrid. A similar rule holds good throughout India, in Jamaica, Trinidad, and many other places, and is frequently the case even in Europe.

We have not touched upon the food-supplies of our naval and mercantile marine as affected by the adoption of the new process; indeed these pages are necessarily far too circumscribed to do justice to this important section of our subject, suffice it that among many other advantages, Messrs. MEDLOCK and BAILEY's new invention affords the means of supplying every sailor, without exception, with fresh, unsalted meat at all times, be the voyage a long or short one, and this, too, without the necessity of diminishing cargo-space by carrying living animals.

The same with passenger ships and steamers. At present on many lines the number of passengers that can be taken is seriously diminished by the cattle, sheep, pigs, poultry, &c. carried for slaughtering on board, to say nothing of provender for them, the necessity for which is of course obvious, while its practical result is to increase the cost of the animals to fully two and a quarter times—in other words, live animals to the value of £100 involve expenses for their food only, amounting to £125 additional before they are consumed. In future, joints and carcasses treated according to the new method, and packed in cloths, barrels, cases, &c. must replace the "unruly live stock," while occupying about one-tenth the space.

There is one point relating to a possible objection likely to be suggested, to which it may be well to give a passing consideration, it is this:—

Almost all "chemical preparations," properly so called, are unsuited for use in connection with food, even if they possess any preservative qualities, on account of their being individually unwholesome, of their acting injuriously upon some of the constituents of food, or because they may impart an unpleasant flavour. Messrs. MEDLOCK and BAILEY's preparation is happily free from all these drawbacks, all its components are to be found *naturally* in the animal economy, and, therefore, cannot be regarded as "foreign substances;" moreover it has been determined by actual experiment to have no injurious action upon kreatine, or any other of the flesh principles, and, as has been before indicated, it cannot impregnate meat in an unpleasant manner, strangers not being able to distinguish the "preserved" from absolutely fresh meat.

It is a well-known, and to householders a melancholy fact, that there is a considerable and ever-increasing difficulty in supplying this country with the necessary quantity of animal food, amounting (according to Mr. Wentworth Scott,) to upwards of 3,600 million of lbs. annually. As a natural consequence, the price of the more important varieties, especially of meat, has much increased of late. The following table, which excludes the greatest extremes, shows the market prices of meat in London sixteen years ago and at present; also the increase per cent. which, however, is still further enlarged upon by the retailer:—

TABLE SHOWING THE LONDON MARKET PRICES OF MEAT IN THE WINTERS OF 1850—51, AND 1866—67.

Description of Meat.	Prices per 8 lbs. Winter of 1850—51.			Prices per 8 lbs. Winter of 1866—67.			Mean Increase in Price.	
	Min.	Max.	Mean.	Min.	Max.	Mean.	Per 8 lbs.	Per Cent.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	
Beef	2 6	4 0	3 3	3 6	5 2	4 4	1 1	33.3
Mutton	3 0	4 4	3 8	3 10	6 2	5 0	1 4	50.3
Veal	2 8	3 8	3 2	4 6	5 6	5 0	1 10	57.9
Pork	3 0	3 8	3 4	3 2	4 2	3 8	0 4	11.1

These figures need no comment: they speak for themselves; well may the editor of the "Catalogue of the Paris Universal Exhibition, 1867," British Section, remark, "Owing to the high price of meat of

late years, several schemes for the introduction of preserved meats from South America, have been set on foot, but hitherto they have remained without any significant results." All such schemes have either been too costly, or have ruined the quality of the meat supposed to be "preserved." Apply the Bisulphite here again, and what would be the result? Why, that any amount of meat from La Plata, where there are about 27,000,000 cattle and 40,000,000 sheep available for the use of Europe; or from Australia, where the numbers are reckoned at 180,000,000 and 300,000,000 respectively, might be effectively and easily preserved, and sold in London or Liverpool at 2½d. or 3d. per pound.

In the metropolis only, nearly 45,000 persons have a direct, and more or less proprietary interest in the retailing of animal food as will be seen by the following table, which is mainly derived from the last census returns, and gives the *lowest* calculation; to this number, multiplied by ten, or more, for the British Empire, this little treatise is specially addressed; with them, in the first place, must rest the consideration of the evils we have here so crudely touched upon, and also let us hope with them will be found the remedy suggested—in the use of the Patent Bisulphite of Lime.

TABLE,
SHOWING THE NUMBER, AND PROPORTION TO THE INHABITANTS, OF THE CHIEF DEALERS
IN ANIMAL FOOD IN THE METROPOLIS.

Description of Dealers.	1851.	1861.	1866.—Estimated.	
			Total No.	Prop. to 10,000 pers.
Population of London	2,362,236	2,803,989	3,037,991	—
Cowkeepers, milk-sellers, &c.	4,530	5,594	6,061	19.9
Cheese-mongers	2,156	2,651	2,872	9.5
Butchers, meat-sellers, &c.	10,719	14,399	15,500	51.3
Poulterers, game dealers, &c.	551	677	733	2.4
Fish-mongers	2,389	3,467	3,756	12.4
Provision curers, dealers, &c.	—	1,245	1,347	4.4
Other dealers in animal food	1,659	196	212	0.7
Street sellers of animal food	11,500	13,000	13,500	44.4
Total	33,504	41,229	44,051	145.0

* Under this head butchers' wives are also included, as being more or less necessary to the business.

There are of course a variety of special applications of this beautiful process which will be made hereafter, and which will readily suggest themselves to the intelligent reader—not the least valuable of such useful applications we imagine will be the means afforded by this invention of bringing into more extended use certain delicacies now confined to a particular place or time of year. As a familiar instance, let us take Whitebait; this dainty little fish has hitherto only been enjoyed in perfection for about a third of the year, and is comparatively unknown except in the immediate vicinity of Blackwall and Greenwich. With the aid of the Patent Bisulphite this gastronomical treat can now be obtained during a longer period, as a jar of the fish may be sent to any place in Europe—this, as we have just indicated, is but "one out of a thousand" of the future uses of Bisulphite of Lime.

Messrs. WILLIAM BAILEY & SON, Horseley Fields Chemical Works, Wolverhampton, have been appointed by the Patentees, to conduct the Commercial and Manufacturing details connected with the carrying out of this Patent on a liberal and comprehensive scale—they having already been engaged, for some years, in working an Invention of similar utility and importance—from their practical experience, and the special facilities at their disposal, they hope to accomplish it with great advantage and convenience to the Public.

WILLIAM BAILEY & SON have engaged to manufacture the Bisulphite of Lime, which they guarantee to supply absolutely pure, and of a standard strength, at 3s. 6d. per gallon, packages included.



Agents for granting Licenses will be appointed in every Sea-port and large Town throughout Great Britain.

ANALYTICAL REPORT

UPON
MESSRS. MEDLOCK AND BAILEY'S
 BISULPHITE OF LIME PATENT, FOR THE
"PRESERVATION OF ANIMAL SUBSTANCES."
 By WENTWORTH L. SCOTT, Esq., F.C.S., F.A.S.L., F.R.S.S.A., ETC.

Analytical Laboratory,
 Westbourne Park, Bayswater,
 London, W. June 4th, 1867.



I HAVE carefully examined the Standard Solution of Bisulphite of Calcium (known commercially as "Bisulphite of Lime"), prepared under Messrs. MEDLOCK and BAILEY's Patent, and I find the same to be a limpid fluid of the specific gravity of 1.000 at 60° F. possessing very remarkable antiseptic properties.

The "Bisulphite of Lime Solution" has been repeatedly analysed by me, both with, and without the knowledge of the Patentees, but the results have always shown the entire absence of all foreign salts, organic matter, or other deleterious substances.

Unlike the generality of commercial antiseptics, the "Bisulphite of Lime," as employed in MEDLOCK and BAILEY's Patent Process, communicates no unpleasant taste or appearance to meat, &c. impregnated therewith, and can therefore be safely used for the preservation of all kinds of animal food, however delicate their structure or flavour may be, while substances so treated, although they remain fresh and sweet for an almost indefinite period, retain their original wholesomeness and nutritive powers unimpaired.

I have experimented very largely with the new Preservative, which I find will instantly arrest the "putrefactive," "acetic," and other fermentations, it being absolutely fatal to all the lower forms of organic life, whether of animal or vegetable origin, and I have much pleasure in certifying it to be the simplest, safest, and most effective means for the "preservation of animal substances" that has yet been brought before the public: this patent being of decided utility to the wealthier classes, and a positive boon to the people at large, nay, and possibly at no very distant day, be the means of adding considerably to the food supplies of this country.

Very numerous specimens of flesh, fish, and fowl, preserved by this process (in Great Britain, Canada, and elsewhere) have been subjected by me to rigid chemical and microscopical scrutiny with unvarying results of a highly satisfactory character.

I consider Messrs. MEDLOCK and BAILEY's patent process to be capable of a hundred useful applications in the preparation and preservation of food.

(Signed)

Wentworth L. Scott.

Chemical and Microscopical Analyst; Member and
 Medalist of the Society of Arts; Author of "Food,
 its Adulterations and the Methods of Detecting
 them," &c. &c.

DE

L'UTILISATION DES EAUX D'ÉGOUT

EN ANGLETERRE

LONDRES ET PARIS

HYGIÈNE — AGRICULTURE

DE

L'UTILISATION DES EAUX D'ÉGOUT

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PAR

A. RONNA

INGÉNIEUR

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1866

UTILISATION DES EAUX D'ÉGOUT

EN ANGLETERRE.

INTRODUCTION.

Il y a peu de questions qui aient aussi vivement préoccupé l'attention publique, en Angleterre, que celle de l'assainissement des villes par la suppression des réceptacles attenant aux habitations et par l'emploi des matières rejetées dans les égouts. A la moindre attaque de l'épidémie, ingénieurs, chimistes et médecins, sans avoir été appelés à donner leur avis sur les moyens préventifs ou préservatifs que commande la plus simple prudence, critiquent ou louent à l'envi les conditions actuelles de salubrité, des eaux, des galeries d'égout, des services de nettoyage, d'arrosage, des usines, etc. L'administration, saisi des plaintes, nomme des commissions; des enquêtes se font; des rapports sont publiés; la presse se mêle à la discussion. Bientôt l'épidémie disparaît avec ses victimes, les enquêtes tombent dans l'oubli; les rapports vont aux archives; les décisions, quand il y en a eu de prises, sont ajournées. Tel a été, jusqu'à cette année, le sort réservé aux travaux considérables confiés par la Chambre des communes, par le *Board of Health* et par l'Administration municipale, aux commissions chargées, depuis 1846, d'étudier les moyens d'utiliser les produits des égouts.

L'extension donnée à la canalisation des villes atteste les progrès réalisés, au prix des plus lourds sacrifices, pour l'assai-

nissement local; mais on peut dire, qu'en définitive, elle n'a fait qu'augmenter les difficultés de l'assainissement général, en livrant aux fleuves des volumes plus considérables de liquides chargés de matières putrescibles qui vicient l'atmosphère et altèrent une des sources d'alimentation et de richesse les plus essentielles au bien-être des populations, de sorte que, voulant purifier d'un côté, on a corrompu de l'autre; que l'on s'est borné à déplacer le foyer d'infection, en empoisonnant les cours d'eau. Voilà pour la question hygiénique!

Au point de vue de l'agriculture, on a continué à perdre des masses énormes de substances fertilisantes qui manquent plus que jamais à la culture, telle qu'elle tend à se pratiquer partout. Aussi, est-on obligé de les remplacer à des conditions onéreuses, soit qu'on aille chercher des engrais naturels dans les contrées éloignées, soit qu'on les fabrique artificiellement sur place. A Londres, par exemple, la Tamise reçoit annuellement (nous choisissons exprès le chiffre le plus réduit) pour plus de 20 millions de francs d'engrais. A Paris, les liquides des bassins de Bondy (ne parlons pas des produits des égouts), que l'on écoule à la Seine, représentent à eux seuls la fumure nécessaire à une dizaine de mille hectares.

En ramenant le problème sur le double terrain de l'assainissement et de l'agriculture, on devait trouver la solution que Londres a finalement adoptée, que Paris cherche encore. En retraçant ici l'ensemble des faits que nous ont fait connaître les publications des enquêtes anglaises et nos visites dans les localités où des applications nouvelles se sont produites, nous n'avons d'autre but que de prémunir contre les errements passés et de hâter une décision sur des améliorations devenues inévitables.

I. — HISTORIQUE.

C'est, on se le rappellera, à la suite des ravages du choléra (1848-49) que fut reconstitué par acte du Parlement le « *General Board of Health* » dans le but de s'enquérir des conditions sanitaires du pays, de proposer et de faire exécuter toutes mesures intéressant l'hygiène générale et de diriger dans ce sens les travaux des Conseils de salubrité, organisés à la même époque sur divers points du royaume; l'enquête agissant avec le pouvoir discrétionnaire que donnent les sanctions du Parlement, se transporta partout où elle pouvait s'éclairer et, en 1850, le *General Board* remettait aux Chambres le Rapport où sont contenus les principes sur lesquels se base la science sanitaire moderne.

En ce qui concerne plus spécialement la métropole, deux réformes devaient s'opérer immédiatement: la distribution à robinet libre des eaux potables dans toutes les habitations; la suppression des fosses d'aisance et, par suite, l'écoulement direct des vidanges à l'égout.

Jusque-là, la distribution d'eau à système intermittent, se bornait aux usages domestiques, puisque sur l'énorme quantité de 200,000 mètres cubes versés dans la consommation journalière, il y en avait à peine 22,000 mètres ou 11 pour 100 pour les services publics. L'eau puisée à la Tamise, dans la ville même, était livrée par les Compagnies, sans avoir été filtrée; quant aux vidanges, elles étaient recueillies dans des puisards et des fosses dépendant de chaque habitation ou de chaque groupe d'habitations. Dans quelques-unes de ces fosses les liquides s'écoulaient par des trop-pleins dans les égouts; mais dans la plupart, surtout quand le sous-sol était perméable, les liquides s'échappaient par infiltration, entraînant avec eux les matières en suspension. Les *water-closet* n'existaient que dans les demeures riches. Les égouts ne recevaient donc que les eaux de drainage et de lavage des rues, les eaux domestiques et une quantité très-limitée d'eaux vannes.

Bien que cet état de choses se soit perpétué dans d'autres villes de moindre importance que Londres, les efforts et les recommandations du Conseil général devaient peu à peu modifier notablement le régime des eaux de drainage. Pour le Conseil, les émanations de toutes substances animales ou végétales en voie de décomposition, sont incompatibles avec la santé publique; elles engendrent des maladies d'un caractère pernicieux. Celle des matières excrémentielles sont particulièrement contagieuses; l'accumulation de ces matières dans des réceptacles voisins des habitations, notamment au centre des districts populeux, est une cause de grave danger. Le seul moyen pratique et économique d'enlever régulièrement et rapidement les vidanges, et de faire disparaître ainsi les causes d'insalubrité inhérentes à leur manutention, consiste à les noyer dans l'eau des égouts par des drains établis dans chaque maison (1). L'eau ralentit la décomposition; les gaz, au lieu

(1) « Aucune population vivant au milieu des impuretés atmosphériques provenant des fosses d'aisance, des égouts, etc., ne peut jouir de la santé ni résister aux attaques des épidémies. La première condition de santé est l'enlèvement immédiat de toutes ordures ou immondices quelconques, au-dessous ou dans le voisinage des habitations. Aucun remède n'est aussi convenable, aussi économique, aussi prompt, que celui fondé sur l'entraînement par l'eau de toutes ces matières. »

Telles sont les conclusions générales du *Board of Health*, dans ses instructions sur le *Drainage* et le *Nettoyement des villes* (1).

Plus tard, lorsqu'il résume, avant de se dissoudre, les actes de son administration de 1848 à 1854 (2) il pose les deux principes suivants :

« 1^o Que dans les villes, toutes les émanations fournies par les matières animales et végétales en décomposition, révèlent l'existence d'un foyer d'insalubrité et de germes endémiques, et dénotent une administration coupable. »

« 2^o Que dans les campagnes, ces mêmes émanations signalent un gaspillage de matières fertilisantes, une perte d'argent, et, par conséquent, un mode de culture vicieux. »

(1) *Minutes of Informations*, etc. Londres, 1852, p. 142.

(2) *Report of the Gen. Board of Health on the administration of the Public Health Act*. Londres, 1854, p. 91.

de s'échapper dans l'atmosphère, se condensent; l'air n'est vicié que si les liquides restent à l'état stagnant, ce qui n'est pas admissible, lorsque la canalisation est bien faite.

Ces axiomes ne tardèrent pas à gagner du terrain dans l'opinion publique et les recommandations du *Board of Health* devinrent bientôt des prescriptions. Déjà, la loi de 1848 (*Public Health Act*) consacrait d'une manière directe le principe de l'intervention officielle dans l'aménagement intérieur des maisons; elle ordonnait que dans toutes celles construites postérieurement ou dont l'insalubrité serait reconnue, les dispositions étaient obligatoires. Les fosses furent donc supprimées; plus de 300,000 fosses d'aisance ont disparu depuis 1848, à Londres seulement. Beaucoup d'autres villes ont suivi cet exemple. Le nombre des *water-closet* augmente proportionnellement; la distribution d'eau ne fut pas augmentée, mais il fut imposé aux Compagnies de reporter leur prise en rivière, à près de 36 kilomètres en amont de Londres et de filtrer les eaux destinées à la consommation; le service à haute pression et à robinet libre fut installé, la canalisation étendue à un grand nombre de points où elle n'existait pas et complétée par des égouts latéraux au fleuve dans les districts anciennement drainés. En même temps, les masses de matières solides déchargées par les émissaires devinrent de jour en jour plus considérables.

L'histoire des progrès tentés à Londres est celle de la plupart des villes anglaises qui se sont conformées, depuis 1848, aux injonctions du *Board of Health*.

Si l'on considère, d'une part, l'accroissement progressif de la population, le morcellement de la propriété dans les villes, l'agglomération des individus sur une surface donnée, et, d'autre part, la teneur de plus en plus élevée en principes organiques, des liquides déversés par les égouts, on s'expliquera facilement l'influence de ces matières putrescibles sur les cours d'eau qui servent d'exutoires aux égouts, et les complications qui en sont résultées pour le bien-être des populations.

L'action désinfectante de l'eau courante est incontestable, car, au contact de l'air, l'oxygénation des matières solubles s'active et elles deviennent inertes. Mais si le volume d'eau n'est

pas suffisant, ou si le courant est contrarié dans sa marche, les matières organiques insolubles entretiennent la décomposition par les gaz que dégagent les dépôts où elles s'accumulent.

C'est ainsi qu'à Londres, malgré une distribution de 140 litres par habitant et par jour, les égouts incomplètement lavés, se déchargeaient dans l'intérieur de la ville, sur les deux rives de la Tamise, jusqu'au commencement de cette année, c'est-à-dire, avant l'achèvement des collecteurs. Le niveau des égouts à leur embouchure était assez peu élevé, pour que leur décharge ne pût s'effectuer qu'à marée basse, de sorte que les eaux croupissaient dans les égouts pendant 18 heures sur 24. Les matières les plus lourdes avaient ainsi le temps de se déposer, tandis que les matières légères, refoulées par la marée, remontaient le cours des égouts jusques dans les habitations. A la marée descendante, le reflux déterminait, au contraire, l'abondance de ces matières sur les berges, où elles avaient fini par former des dépôts infects qui, en été, restaient exposés à l'air. Les effluves créés étaient devenus si intolérables que, dans les dernières années, on a dépensé par semaine, jusqu'à 25,000 francs pour désinfecter les égouts pendant quelques semaines, indépendamment de la somme de fr. 750,000, affectée annuellement à leur curage.

Dans les districts manufacturiers et populeux, traversés par des cours d'eau, les mêmes faits que ceux ressentis à Londres se sont reproduits. Ici comme dans la métropole, les rivières transformées en cloaques à ciel ouvert, sèment des miasmes et ne peuvent plus, depuis longtemps, concourir à l'alimentation. Partout où l'on a pu trouver des sources ou capter les eaux superficielles de drainage, on a abandonné les distributions d'eaux de rivière. Dans bien des cours d'eau, le poisson a disparu au détriment des classes qui s'en nourrissaient.

Ainsi, la Mersey et l'Irwell, à Manchester; la Mersey, à Stockport; la Tame, à Birmingham; la Tyne, à Newcastle, etc., sont devenues des égouts. La Tamise, en amont des prises d'eaux qui sont distribuées à Londres, c'est-à-dire à plusieurs lieues avant son entrée dans la ville, a déjà reçu les déjections de 700,000 habitants. La petite rivière Tame, avant d'atteindre

Birmingham, entraîne les *excreta* d'une population de 270,000 individus, etc.

On conçoit que, dans ces circonstances, les procès n'ont pas été épargnés aux autorités municipales, qui avaient, d'après les prescriptions du Conseil général de salubrité, concentré sur un ou deux points la décharge des eaux. C'est le plus souvent sous l'empire des assignations lancées par les riverains, qu'ont été tentés les essais de filtrage, d'épuration chimique et d'arrosage dont nous nous proposons de rendre compte.

II. — COMPOSITION ET VALEUR DES EAUX D'ÉGOUT.

Les matières qu'entraînent les eaux d'égout, varient suivant les quartiers ou les districts d'une même ville, suivant la densité de la population, ses habitudes domestiques et ses occupations, suivant la saison, le jour et l'heure, enfin, suivant l'état atmosphérique. C'est assez dire combien l'analyse chimique est impuissante à établir d'une manière certaine la quantité d'éléments que dissolvent ou charrient ces liquides. Ces éléments se composent surtout des déjections des animaux, des eaux ménagères, des urines répandues sur la voie publique et des produits des fosses écoulés aux égouts. Parmi les analyses nombreuses auxquelles ont donné lieu ces eaux, nous avons choisi celles qui semblaient se recommander par le soin apporté à leur dosage, et nous en avons dressé un tableau résumant, pour différentes villes, les proportions de matières solubles et insolubles, organiques et inorganiques. Nous faisons suivre ce tableau de quelques analyses complètes dues à des chimistes compétents.

NUMÉROS.	DATE DES ESSAIS.	LOCALITÉS ET NOMS DES ÉGOUTS.	CHIMISTES.	MATIÈRES EN SUSPENSION			MATIÈRES EN DISSOLUTION			MATIÈRES TOTALES			POIDS PAR LITRE D'EAU D'ÉGOUT		
				organiques.	minérales.	total.	organiques.	minérales.	total.	organiques.	minérales.	total.	anale.	synthé- que.	
LONDRES.															
1	1846	King's Scholar's Pond.	Brande et Cooper	-	-	0,150	-	-	1,066	-	-	1,216	-	-	
2	1858	Id. id. id.	Hoffmann	0,276	0,717	0,993	0,085	0,525	0,610	0,361	1,242	1,603	0,046	-	
3	1850	Dorset square	F. Way	-	-	1,435	-	-	1,554	-	-	2,989	-	0,256	
4		Moyenne de 24 analyses		0,240	0,300	0,540	0,210	0,590	0,800	-	-	1,340	-	0,045	
5	1854	Id. des eaux recueillies la nuit	Letheby	-	-	0,210	-	-	1,000	0,240	0,970	1,210	-	-	
6		Moyenne générale		0,220	-	0,430	0,220	-	0,800	-	-	1,290	-	0,200	
7		Savoy Street		0,156	0,212	0,368	0,281	0,818	1,099	0,437	1,090	1,467	-	-	
8		Falcon id.		0,023	0,027	0,050	0,340	0,544	0,578	0,363	0,571	0,934	-	-	
9	1858	Earl id.	Hoffmann	0,020	0,021	0,041	0,018	0,637	0,655	0,038	0,658	0,696	-	-	
10		Fleet id.		0,250	0,660	0,910	0,081	0,670	0,751	0,331	1,330	1,661	-	-	
11		Northumberland id.		0,469	0,247	0,707	0,587	0,856	1,443	1,047	1,103	2,150	-	-	
Moyennes.											0,402	0,986	1,505	-	-
ÉDIMBOURG.															
12	1846	Collecteur Foul Burn	Phillips	-	-	1,520	-	-	1,170	-	-	2,690	-	-	
13		Id. au sortir des bassins		-	-	0,660	-	-	1,230	-	-	1,890	-	-	
14	1846	Sans indication d'égouts	T. Cooper	-	-	1,120	-	-	1,112	-	-	2,238	-	0,063	
15	1850	Lochend	Anderson	-	-	-	-	-	-	-	-	1,500	-	0,100	
16		Morningside Asylum		-	-	-	-	-	-	-	-	1,892	-	0,045	
17	1858	Sans indication d'égout	Hoffmann	-	-	-	-	-	-	0,738	1,153	1,891	-	-	
18	1864	Moyenne générale de 105 analyses d'eaux d'égouts déchargés dans la Leith.	Stev. Macaulay	0,245	0,570	0,815	0,404	0,196	0,600	0,650	0,765	1,415	-	-	
Moyennes.											0,699	0,959	1,930	-	-
RUGBY.															
19	1864	a. Moyenne	T. Way	0,576	0,661	1,237	0,150	0,640	0,799	0,735	1,301	2,036	-	0,123	
20		b. Moyenne		0,462	0,754	1,216	0,142	0,654	0,796	0,604	1,400	2,004	-	0,125	
LEICESTER.															
21	1857	a.	Aikin et Taylor	-	-	1,990	-	-	1,400	-	-	3,390	-	-	
22	1858	b.	Hoffmann	-	-	-	-	-	-	0,296	1,154	1,450	-	-	
MANCHESTER.															
23	1846	a.	T. Cooper	-	-	0,040	-	-	1,102	-	-	1,151	-	0,057	
ALNWICK.															
24	1857	Moyenne de 3 analyses	Richardson	-	-	-	-	-	-	0,533	0,673	1,206	0,032	-	
BIRMINGHAM.															
25	1860	Heckley et rivière Lea	A. Voelcker	-	-	-	-	-	-	-	-	0,941	0,032	-	
PARIS.															
26	1858	Egout de la rue Rivoli.		-	-	0,480	-	-	1,240	-	-	1,720	0,058	-	
27		a. Collecteur d'Assinieres		-	-	-	-	-	-	2,071	1,420	3,491	-	-	
28		b. Id. 25 mai		-	-	-	-	-	-	0,963	1,149	1,512	0,030	-	
29		c. Id. 28 id.		-	-	-	-	-	-	0,272	0,811	1,083	-	-	
30	1860	d. Id. 12 juin	H. Mangon	-	-	-	-	-	-	0,871	2,077	2,948	0,062	-	
31		e. Id. 24 id.		-	-	-	-	-	-	0,075	1,781	2,456	-	-	
32		f. Id. id. novembre		-	-	1,410	-	-	1,433	0,760	2,083	2,843	0,070	-	
Moyennes.											0,735	1,553	2,288	-	-
MILAN.															
33		La Martesana octobre.		-	-	-	-	-	-	0,011	0,079	0,090	-	-	
34	1861	La Vettabla inférieure id.	H. Mangon	-	-	-	-	-	-	0,010	0,097	0,107	-	-	
35		Id. supérieure id.		-	-	-	-	-	-	0,016	0,211	0,227	-	-	
36	1862	Id. id. mars		-	-	-	-	-	-	0,013	0,206	0,229	-	-	

ANALYSES COMPLÈTES DE QUELQUES EAUX D'ÉGOUT.

	LONDRES.				
	King's Scholar.	Dorset Square.	EDINBOURG.	MANCHESTER.	ECRY.
<i>En dissolution.</i>					
Matières inorganiques . . .	1	2	3	4	5
Oxyde de fer	0,029	traces	"	"	traces
Chaux	0,086	0,105	0,097	0,101	0,120
Magnésie	0,045	0,091	traces	0,015	0,025
Potasse	"	0,037	"	"	0,025
Soude	"	"	indét.	"	0,107
Chlore	0,142	"	0,172	0,137	0,100
Chlorures de sodium et de potes . . .	"	0,389	"	"	"
Acide sulfurique	0,031	0,004	0,043	0,037	0,063
Acide phosphorique	"	0,036	"	"	0,018
Phosphate de chaux	0,007	"	0,015	indét.	"
Acide carbonique	0,025	0,151	"	"	0,126
Acide carbonique	0,309	0,028	"	"	0,025
Silice et sable	0,302	0,803	indét.	indét.	0,160
Matières organiques azotées . . .	"	"	"	"	"
Total	1,066	1,554	1,112	1,102	0,799
<i>En suspension.</i>					
Matières inorganiques . . .	"	0,038	"	"	0,065
Oxyde de fer et alumine . . .	"	0,119	"	"	0,064
Chaux	"	traces	0,009	"	0,009
Magnésie	"	0,010	"	"	"
Potasse	"	0,030	"	"	"
Chlorure de sodium	"	0,052	"	"	"
Acide sulfurique	"	0,023	"	"	0,026
Acide phosphorique	"	"	0,094	0,013	"
Phosphate de chaux	0,034	"	"	"	"
Acide carbonique	"	0,028	"	"	0,046
Carbonate de chaux	0,027	"	0,039	traces	"
Silice et sable	0,089	0,807	0,420	0,024	0,450
Matières organiques azotées . . .	"	0,328	0,563	0,012	0,576
Total	0,150	1,435	1,126	0,049	1,236
Ammoniaque	0,047	0,256	0,063	0,057	0,123

1, 3 et 4, analyses de T. Cooper.
2, analyse du professeur Way.
5, analyse du professeur Way.

Eaux des égouts de Paris (1).

	1.	2.	3.	4.	5.
Produits volatils non compris l'azote.	0,630	0,90	0,33	0,19	1,575
Azote.	0,058	0,07	0,04	0,04	0,026
Cendres.	1,506	1,24	1,19	4,03	1,242
Poids total du résidu solide par litre.	2,194	2,21	1,56	4,26	2,843

Analyse du dépôt naturel des eaux d'égout, à Birmingham (2).

Eau.	47,47
Matière organique contenant azote 0,44 = 0,50 ammoniacale . . .	17,61
Sulfure et oxyde de fer et alumine . .	0,40
Phosphate de chaux	1,10
Sulfate de chaux	0,22
Carbonate de chaux	0,52
Carbonate de magnésie	0,09
Sulfure de cuivre et de zinc . . .	0,94
Chlorure de sodium	0,05
Sable	28,07
	100,00

Ainsi, les matières minérales consistent surtout en carbonate de chaux, en chlorure de sodium, en phosphates et en sulfates alcalins, fournis principalement par les eaux de la consommation et par les urines. Les matières insolubles proviennent presque entièrement du pavé, des roues et de l'usure des fers des chevaux.

(1) Analyses de M. Hervé-Mangon : le n° 1 représente un échantillon de l'eau de l'égout Rivoli; le n° 3 est un échantillon moyen d'eaux recueillies à 8 heures du matin, midi, 4 heures et 8 heures du soir; le n° 4 des eaux recueillies de 5 heures du matin à midi et de 6 heures du soir à minuit; le n° 5 s'applique à des eaux puisées au mois de novembre 1860.

(2) Analyse du Dr Voelcker. Les eaux ne déposent en moyenne que 0,208 par litre, tenant 0,006 d'azote.

Les matières organiques jouent le rôle le plus important dans le résidu solide que laissent les eaux après l'évaporation. Sous le microscope, la présence des matières en décomposition est des plus apparentes; ce sont des utricules ou des petites cellules de blé, de pommes de terre, de choux, etc., provenant des matières fécales. L'action de l'iode sur l'amidon de ces cellules confirme leur origine. Les animalcules sont peu nombreux, et leur absence s'explique par la formation de gaz délétères dans le sein des eaux; les seuls reconnus jusqu'ici appartiennent au genre *monas* et aux *annélides*. Enfin, M. Hassall a constaté la présence de deux substances particulières; l'une noire, charbonneuse, qui colore les eaux; l'autre, ocreuse, analogue à la fibre musculaire, qui rappelle celle des matières excrémentielles.

Les matières organiques donnent naissance à un dégagement de gaz d'autant plus considérable, qu'elles arrivent fraîches, à l'état de ténuité propre aux réactions chimiques, dans un volume d'eau qui suffit à peine pour les tenir en suspension et dont le degré de température est le plus souvent favorable à la décomposition. En outre, au contact d'une substance organique quelconque, les eaux qui avaient déjà fermenté, peuvent reprendre leur action. Les composés fermentescibles, promptement altérables, sont ainsi transformés en produits nauséabonds. Le sucre devient de l'acide lactique, puis de l'acide butyrique à odeur fétide et enfin de l'hydrogène et de l'acide carbonique. Les substances albuminoïdes donnent de l'ammoniaque, de l'acide carbonique et de l'acide sulfhydrique, etc.

Si l'on porte à l'ébullition le liquide des égouts, après décantation, on recueille simultanément, de l'ammoniaque, de l'hydrogène sulfuré, du gaz des marais, de l'acide carbonique et de l'azote.

Dans les eaux des égouts de Londres, on a constaté que le volume des gaz ainsi recueillis atteignait de 115 à 275 centimètres cubes par litre d'eau. La proportion de gaz acide carbonique variait entre 35 et 70 %; celle de l'hydrogène sulfuré de 1 à 3. Pendant la première semaine le volume des gaz dégagé (expériences du Dr Letheby), était de 10 centimètres cubes par heure; à la fin de la troisième semaine, de 5 centi-

mètres cubes; après la neuvième semaine, de 0^{re},66. On a ainsi constaté, pour les eaux des égouts de la Cité, que sur 100 litres de gaz il y avait :

Hydrogène carboné	72
Acide carbonique.	17,7
Azote.	10,2
Hydrogène sulfuré.	0,08
Ammoniaque	0,02
	100,00

D'autres gaz volatils, d'une odeur caractéristique, n'ont pu être isolés, bien qu'ils paraissent se rapprocher de l'ammoniaque. Quant à ce dernier corps, si intéressant pour l'agriculture, le Dr Letheby a trouvé que la proportion s'élevait dans les eaux courantes des égouts de 0^{re},04 à 0^{re},20 par litre (Tableau p. 8) et, dans les eaux stagnantes, de 0^{re},20 à 5^{re}.

Le professeur Way, chargé par la Commission d'enquête de 1861, d'analyser les eaux des égouts de Londres, de Croydon, de Coventry, etc., y a recherché l'azote sous les deux états, de sels et de matière organique. L'azote disponible immédiatement pour la végétation, est, en effet, dissous dans le liquide, tandis que l'azote des matières organiques est, pour la plus grande partie, à l'état insoluble. Voici les moyennes des dosages d'azote faits en tenant compte de cette division :

NOMBRE D'ESSAIS.	DATE.	LOCALITÉS.	AMMONIAQUE PAR LITRE		
			en dissolution.	en suspension	
3	mars avril	1859	Londres	0 ^{re} ,002	0 ^{re} ,0412
12	avril juin	1861	Croydon Coventry Rugby	0 ^{re} ,051	0 ^{re} ,0160

L'ammoniaque existerait donc en plus grande quantité, en dissolution qu'en suspension. Pour apprécier la quantité maximum de ce corps que le repos ou la fermentation peut développer, M. Way a puisé le 7 février des eaux dans l'égout Northumberland (Londres); ces eaux renfermaient à cette date 0^{re},058 d'ammoniaque soluble par litre; le 12 février, la proportion atteignait 0^{re},095 et restait stationnaire. Dans un autre essai sur de l'eau puisée le 24 mars, l'ammoniaque soluble représentait 0^{re},074 par litre; le maximum de 0^{re},115, fut atteint le 31 mars suivant.

Ainsi, toute l'ammoniaque fournie par l'urée et par les autres substances ne se dégage qu'après quelques jours de repos; tandis que les azotates alcalins ou terreux, dont l'analyse chimique permet de connaître de suite la proportion, se transforment en acide azotique.

Valeur des eaux d'égout. — La valeur intrinsèque des eaux d'égout a donné lieu à des appréciations diverses dans les villes où il importait de fixer la richesse fertilisante jetée annuellement dans les rivières. Deux procédés ont servi jusqu'ici à ces déterminations : le premier consiste à choisir le poids moyen de déjections solides et liquides par individu et à ajouter au total que donne ce poids multiplié par le nombre d'habitants, les produits fournis par les manufactures et la voie publique; le second se borne à calculer la quantité de matières solides d'après les résultats des analyses faites à diverses heures du jour et dans les différentes saisons.

Si nous prenons Londres pour exemple, MM. Way et Lawes appliquant le premier procédé de calcul, ont établi que le poids total de matière sèche, par individu et par an, est de 20^{re},86 sur lesquels il y a 13^{re},86 de matières organiques et 5^{re} de matières minérales. Parmi les matières organiques, l'ammoniaque est à peu près le seul élément qui ait une valeur fertilisante; tandis que, dans les matières minérales, il ne faut compter que sur l'acide phosphorique, le phosphate de chaux et la potasse. Pour une masse totale de matières pesant à l'état sec 51,287 tonnes, M. Lawes estime que la quantité annuelle d'azote dans les eaux des égouts de Londres, s'élève à 8,859 tonnes, corres-

pondant à 10,758 tonnes d'ammoniaque. Il est vrai que toutes les déjections ne vont pas aux égouts, et il y a à ajouter les produits des usines sur lesquels on n'a pas de données certaines, ainsi que ceux du nettoyage de la voie publique. Sur ce dernier point, M. Way a constaté que l'eau puisée aux regards des égouts après l'orage ou les grosses pluies, tenait par litre 3^{re},70 de matières en dissolution et 2^{re},10 en suspension. Le chiffre total de l'azote est indépendant de ces substances additionnelles.

Le second procédé est fondé sur les données de l'analyse chimique. Des dosages du D^r Letheby, il ressort que le montant de matières solides provenant d'eaux recueillies dans divers collecteurs de la Cité est de 1^{re},340 par litre pendant le jour et de 1^{re},127 pendant la nuit, ce qui donne une moyenne pour les 24 heures de 1^{re},234 par litre, dont 0^{re},417 en suspension comprenant 0^{re},22 de matière organique, et 0^{re},817 en dissolution renfermant 0^{re},22 de matière organique.

Sur 496 tonnes de matières solides entraînées journellement par les égouts, le D^r Letheby admet la division suivante :

Matières fécales.	155 tonnes.
Granite, fer, etc., provenant des chaussées, chevaux, etc.	82
Sels des eaux de la consommation.	104
Matières des usines, etc.	153
Total.	496

comprenant 218 tonnes de matières organiques, dont moitié en dissolution et moitié en suspension.

Mais la moyenne établie par M. Letheby est sujette à discussion. Ainsi, sur 24 de ses analyses, 15 donnent seulement une moyenne de 0^{re},940 de matières solides par litre, et dans les neuf autres, la moyenne est de 1^{re},755. Si l'on réfléchit que cet excès correspond à des jours pluvieux et est représenté en grande partie par des matières inertes, on aura plus de chance de s'approcher de la vérité, en prenant pour moyenne 1^{re} par litre qu'en adoptant celle de 1^{re},234 fixée par le D^r Letheby, ou celle de 1^{re},435 admise par MM. Hoffman et Wilt.

C'est, du reste, le chiffre auquel ont été conduits les chimistes Voelcker, Wrighston, etc., dans leurs essais sur les eaux d'autres villes, Birmingham, Liverpool, etc. En tous cas, comme le fait justement remarquer M. Way, à l'occasion des analyses des égouts de Dorset-Square et d'Oxford-Street (tableau p. 10) qu'il recommença dix années plus tard, en constatant moitié moins d'azote : « Aucun échantillon recueilli pendant une certaine période de l'année, ne peut donner une indication précise de la valeur des eaux de toute une ville. C'est au collecteur général seulement qu'on peut espérer obtenir une approximation, et encore, serait-on certain d'avoir dosé tous les éléments, que l'on n'arriverait pas à fixer la valeur pécuniaire du liquide. »

En effet, il y a dans tous ces calculs un coefficient variable dont l'importance n'échappera à personne, c'est le volume des eaux. Pour Londres, par exemple, il n'y a moins de trois chiffres officiels dont l'écart représente un tiers du volume total annuel.

VOLUME DES EAUX DE LONDRES

	des égouts,	de pluies,	total.
D ^r Franklin . . .	132,000,000 ^{m3}	75,000,000 ^{m3}	207,000,000 ^{m3}
Bazalgette . . .	158,000,000	111,000,000	269,000,000
Capitaine Galton .	216,000,000	112,000,000	328,000,000

Aussi, l'évaluation en argent de la richesse fertilisante des eaux donne-t-elle lieu aux résultats les plus contradictoires. Selon M. Mechi, entendu à toutes les enquêtes parlementaires, l'engrais des eaux de Londres représente une valeur de 50 millions de francs par an (1); la valeur théorique étant de 60 millions. Mais ailleurs, il affirme que le mètre cube ne vaut pas plus de 0,20 (2), ce qui ne ferait plus que 28 millions; et, plus loin, il ajoute que la valeur de l'engrais fourni par une

(1) *Report on Sewage (metropolis)*, juillet 1864; n° 1022, 1053 et 1057.
(2) Même rapport, n° 1033, 1034 et 1060.

population de 20,000 âmes, atteint la modique somme de 25,000 francs par an (1). Or, M. Mechi a appliqué l'engrais liquide pendant 20 ans sur sa ferme de Tiptree !

Lord Essex, qui a également utilisé les eaux de Watford, estime à 20 millions de francs seulement le produit des égouts de Londres (2).

Le Comité municipal « *Coal, Corn and Finance* », sans tenir compte de ces extrêmes, ne craint pas, dans son Rapport à la corporation de la Cité de Londres (3) de fixer la valeur annuelle des matières à 72 millions de francs. D'après ce rapport, les 266,052,440 mètres cubes d'eaux déversées annuellement par les égouts métropolitains, renferment une quantité de matières fertilisantes équivalente, à l'état sec, à 212,842 tonnes de guano du Pérou, côté à 340,60 la tonne. Le Comité, en conséquence, insiste pour qu'une pareille richesse appartenant aux contribuables ne soit pas gaspillée et pour que le « *Conseil métropolitain* » suspende toute décision à l'égard de la concession de ces eaux.

Si nous passons aux évaluations fondées sur l'analyse récente des eaux, nous remarquons, avec le D^r Hoffmann, que le mètre cube a une valeur de 0,20 en moyenne; soit de 95,000 francs par jour et de 34 millions de francs pour l'année. Ses calculs sont rapportés au guano côté à 275 francs la tonne, dans lequel l'ammoniaque se paie 1,40 le kil.; le phosphate de chaux 0,175 et la potasse 0,77; ce qui donne au résidu solide, par mètre cube, une valeur, en nombres ronds, de fr. 150 la tonne.

Le D^r Voelcker a contrôlé ces chiffres en se référant à la composition moyenne des eaux, qu'il établit de la manière suivante :

(1) *Report on Sewage (metropolis)* juillet 1864, n° 1130.
(2) *Report on Sewage*, 1864, n° 48.
(3) Rapport du 8 novembre 1864.

Composition moyenne des eaux d'égout de Londres (1).

	1 mètre cube d'eau contient :	1 tonne de matière sèche contient :
Matières organiques et sels ammoniacaux renfermant	0 ^a ,427	333 ^a ,69
Ammoniaque	0 ^a ,099	72 ^a ,02
Matières minérales	0,855	
renfermant :		666,31
Acide phosphorique. . . .	0,014	10,27
Potasse	0,042	30,82
Matières inertes	0,798	62,54
Totaux,	1 ^a ,282	1000,00

De sorte que, si l'on évaporait, un mètre cube de liquide, on obtiendrait, à l'état sec, 2/3 de matières inertes, complètement inutiles. Aussi, ne peut-on comparer ces eaux avec le guano, sans tenir compte de l'excès d'eau, et en admettant qu'on néglige cet excès, ne doit-on pas oublier que le guano ne contient pas, pour ainsi dire, de matières inertes. Si l'on adopte 4^a,35 pour le prix du kilogramme d'ammoniaque, 0^a,65 pour le kilo de potasse et 0^a,45 pour le kil. d'acide phosphorique, on n'a plus, d'après le Dr Voelcker, que 128 fr. par tonne de matières sèches, ce qui correspond à une valeur de 0^a,175 par mètre cube d'eau.

M. Hervé Mangon, adoptant pour la richesse en azote des eaux d'égout de Paris, le chiffre (probablement au-dessous de la vérité) de 0^a,0582 par litre, et le poids, pour les matières dissoutes ou en suspension, de 2 grammes par litre, a cherché à évaluer la quantité de matières fertilisantes entraînées et perdues annuellement. Il fallait, pour cela, connaître leur volume : M. Mangon a fixé par année à 21,900,000 m. cubes de liquide au même degré de concentration que celui qui avait servi à un essai. D'après ces hypothèses, les eaux des égouts de Paris contiendraient :

(1) *Lecture on Town Sewage*, Londres, 1862.

Azote de l'ammoniaque . . .	851,910 ^a	} 1,272,390 ^a
Azote des matières solides .	420,480	
Matières organiques non compris l'azote		12,899,100
Matières minérales		30,879,000
Total,		45,050,490

En vérifiant la richesse en azote sur les données synthétiques que fournit l'état des chevaux qui circulent dans les rues de la capitale, M. Mangon adopte le chiffre de 1,200,000 kil. d'azote(1), soit, au prix de 1^a,40 fixé par le Dr Voelcker, une valeur de 16,800,000 francs. L'écoulement des produits des fosses dans les égouts doublerait cette valeur, car il leur apporterait 1,400,000 kil. d'azote ou plus.

Toutes ces données, quelque approchées qu'elles soient, sont erronées quant à la valeur pratique des eaux comme fertilisant. Nous avons démontré ailleurs (2) qu'il fallait faire entrer en ligne de compte le volume et l'état physique de l'engrais. Le guano constitue un engrais maniable que l'on apporte où, quand et comme on le désire sur le sol, de façon à fournir aux plantes, à un moment critique de leur végétation, un aliment abondant. La même quantité de guano ou de superphosphate répandue en couverture, vient-elle à être mélangée avec la masse du sol, sur une épaisseur de 0^a,40 par exemple, qu'elle ne remplit pas le même but. Par ce fait, on ne peut pas modifier matériellement la composition du sol, pris en masse, quelle que soit la quantité d'engrais dont on dispose, ni étendre l'action fertilisante au-delà de la surface. La pratique du fermier se borne donc à n'engraisser que la mince croûte superficielle nécessaire à l'alimentation première de la plante : et par cette raison, les engrais concentrés, guano ou superphosphate, sont utiles, dans les sols sableux, au contraire, où il faut tout apporter,

(1) Note sur la valeur, comme engrais, des produits de la voirie de Paris. *Ann. des Ponts et Chaussées*, 1850.

(2) *Fabrication et emploi des phosphates de chaux en Angleterre*, par A. Rouba, ingénieur, 1864.

des engrais volumineux, tels que le fumier et les eaux d'égout, s'appliquent avec plus de profit que les engrais concentrés.

La valeur des eaux d'égout aurait donc dû être calculée par rapport au fumier de ferme, au lieu du guano; les résultats auraient été alors bien différents. En se guidant sur l'analyse seulement, le fumier de ferme bien consommé vaudrait 16,85 (1); mais on ne le paye effectivement que 4 à 6 francs la tonne. Pourquoi alors, s'il s'agit d'un engrais plus volumineux et d'un emploi bien plus gênant que le fumier, ne pas diminuer proportionnellement la valeur théorique.

Le chiffre réel est donc celui qui résulte de l'emploi agricole des eaux. C'est celui que les enquêtes ont permis d'établir et qu'on trouvera plus loin.

III. — ÉPURATION DES EAUX D'ÉGOUT.

L'épuration des eaux d'égout a pour but de transformer en un liquide incolore, limpide, inodore, et se rapprochant le plus possible des eaux courantes de la surface, les liquides noirs, troubles et fangeux, chargés de principes putrescibles et de gaz méphitiques que déversent les égouts. Ce but n'est atteint que si : 1° on sépare de ces liquides les matières en suspension, en leur enlevant toute faculté de se décomposer ultérieurement et d'engendrer des miasmes; 2° si on désinfecte chimiquement les liquides avant de les laisser se perdre, de façon à assurer leur innocuité.

(1) Ce prix se décompose ainsi d'après la composition du fumier de ferme (A. Voelcker, *Lecture on Farmyard manure*, Londres 1857).

	Par tonne
Phosphates solubles	38,85 = 20,50
Potasse	4,33 = 3,10
Ammoniaque	7,25 = 10,00
Phosphates insolubles	5,67 = 1,35
	16,85

Les procédés appliqués jusqu'ici ne remplissent ce programme que très-imparfaitement, surtout au point de vue économique. Nous les passerons en revue en les rapportant à trois catégories :

- 1° Filtrage et décantation; c'est le traitement mécanique qui sépare les matières en suspension par le repos ou par des filtres;
- 2° Désinfection proprement dite, avec ou sans précipitation;
- 3° Précipitation ou traitement chimique proprement dit.

1. — FILTRAGE.

La décantation dans des bassins et le filtrage des eaux sont appliqués dans la plupart des villes importantes de l'Angleterre. Il est incontestable qu'une masse de matières fermentescibles a été ainsi détournée des cours d'eau qu'elles dénaturaient; mais ces procédés purement mécaniques n'exercent aucune action sur les matières en dissolution, et sont, par cela même, insuffisants. C'est ce qui ressort de la description suivante des modes de filtrage employés dans plusieurs localités.

Birmingham. — La municipalité de Birmingham venait à peine de compléter le drainage par la construction de deux collecteurs parallèles, qu'elle reçut du Chancelier l'ordre de purifier les eaux des égouts avant de les rejeter dans la rivière Tame. Après des expériences faites sous les yeux d'une commission et sur la proposition du chimiste, M. Lindsay-Blyth, on vota une somme de 105,000 francs pour l'épuration des eaux. Un bassin de 100 mètres de longueur, 30 mètres de largeur et 2^m,10 de profondeur, fut construit sur un terrain situé près du confluent de la Rea et de la Tame. Ce bassin est divisé en trois compartiments; chacun de ces compartiments communique à volonté avec la rivière par une rigole latérale ou avec le compartiment voisin par un barrage mobile. La communication avec la rigole n'a lieu qu'à travers des claies filtrantes. Les deux premiers compartiments servent au dépôt des liquides, le troisième contient deux filtres, dont un *per ascensum*, de 450 mètres carrés de surface, est formé d'une grille de fer recouverte de 0^m,08 de gros gravier et de 0^m,22 de sable. L'autre filtre *per descensum* a été abandonné parce qu'il ne fonctionnait pas.

Les liquides des égouts à Birmingham sont d'une nature exceptionnelle, car en présence des acides libres, les matières solides s'y précipitent très-promptement. Ainsi, après cinq semaines, le premier compartiment reçoit jusqu'à 1^m,50 d'épaisseur de dépôt, et le deuxième, 0^m,40, et le filtre *per ascensum* ne retient guère plus de 0^m,07 à 0,10, c'est-à-dire à peine 3 % des matières en suspension.

En présence du résultat du filtrage, le second bassin destiné à alterner avec le précédent, de manière à prévenir toute interruption dans le service, n'a pas été pourvu de filtres. Aujourd'hui, on retire journellement d'un volume moyen de 55,000 mètres cubes d'eau, 60 à 80 tonnes de matières solides que l'on se borne à sécher à l'air. Les frais d'entretien, etc., des bassins sont, par an, de 35 à 40,000 francs. La tonne de matières se vend, en petites quantités à 0^m,60 la tonne, aux maraîchers et aux jardiniers des environs, mais le plus souvent il faut les donner gratis aux paysans, moyennant qu'ils les enlèvent à leurs frais (1). Cet enlèvement, le chargement sur bateau, etc., représentent environ 15 fr. par bateau de 25 mètres cubes.

M. Blyth, chimiste, avait proposé, dans son rapport, de précipiter les eaux dans le second compartiment par de la craie ou du calcaire à demi calciné, ce qui eût dispensé d'un troisième compartiment et assuré une épuration plus complète. En présence de l'acide sulfurique libre, des sels métalliques, et de la faible proportion de matières organiques, la craie aurait suffi pour neutraliser l'acide, précipiter les oxydes et fixer une partie de l'ammoniaque. Mais le traitement mécanique a prévalu, au détriment de la salubrité du voisinage et des eaux.

Plymouth. — A Plymouth, on s'est borné, pour se conformer aux règlements sanitaires, à construire deux séries de bassins voûtés. Ces bassins de dépôt bâtis dans les eaux mêmes de la baie Deadman, forment un des quais du port; ils communiquent entr'eux par un trop plein et n'offrent rien de particulier que leur prix de construction (125,000 fr.)

(1) Ce dépôt consiste pour la plus grande partie, en sable provenant des chaussées macadamisées.

Bilston. — A Bilston, le procédé est simple. Des filtres sont établis sur 60 mètres de longueur dans le collecteur même qui mesure 1^m,50 sur 1^m,20; ces filtres, formés de scories et de mâchefers, sont partagés en cinq longueurs. Le compartiment voisin de l'émissaire est le plus chargé de matières; on en est quitte pour y renouveler plus souvent les scories. Les eaux sortent très-limpides; les scories sont remplacées cinq à six fois par an.

Ashby. — L'installation de la petite ville d'Ashby-de-la-Zouch (4,000 habitants) mérite d'être citée pour l'économie avec laquelle elle a été faite.

Les bassins de dépôt sont en communication par des filtres formés de planches perforées, plantées à 0^m,90 de distance et dont l'intervalle est rempli de cailloux et de graviers. Les dimensions de ces cailloux sont moindres au fur et à mesure que les filtres s'éloignent davantage de l'émissaire. Il y a trois séries de bassins ainsi partagés par des filtres. Dans la première série le curage s'opère toutes les 6 ou 8 semaines; dans la seconde, une fois par an; la troisième dure plus longtemps encore sans nettoyage.

On extrait par an de 80 à 100 tonneaux de matières, que l'on vend couramment au prix de 3 fr. l'un.

Cette installation représente la dépense annuelle suivante :

Location du terrain.	fr. 125 »
Annuité et intérêt sur le capital de construction (2,000 fr.)	» 126 50
Frais d'exploitation.	» 195 »
Total, fr.	446 50
Produit de la vente de l'engrais (90 tonneaux à 3 fr.).	fr. 270 »
Reste, fr.	176 50

soit une dépense d'environ 0,045 par habitant.

Workop. — L'ingénieur Rawlinson, connu par ses travaux d'assainissement, a fait établir les bassins de Workop où il s'est

proposé de faire déposer les eaux, puis de les filtrer à travers des claies mobiles.

Les tranchées ou fossés à ciel ouvert dont les radiers sont à 0^m,30 de profondeur au-dessous de l'émissaire, sont au nombre de six, et mesurent 60 mètres de longueur, sur 0^m,45 de largeur au fond. Ces tranchées sont rangées sur deux parallèles dont la distance est de 4 mètres. A chaque extrémité sont disposés des vannes qui permettent de faire fonctionner simultanément le nombre de bassins nécessaire ou de perdre les eaux directement à la rivière (planche 1). La section est calculée dans le rapport de 10 à 1, relativement à celle de l'émissaire, afin de diminuer proportionnellement la vitesse du courant. Des claies mobiles, en osier, sont transportées d'une tranchée à l'autre, suivant le besoin, pour filtrer les eaux avant qu'elles ne se rendent, par deux rigoles, dans la rivière Ryton.

Le curage s'opère périodiquement, les frais représentent de 0^e,70 à 0^e,90 par mètre cube. On enlève chaque mois 20 mètres cubes de matières que l'on rejette sur les bords des fossés, et que l'on vend au prix de 3 fr. le mètre cube. Un bassin spécial, muni d'une pompe, a été installé pour y préparer du lait de chaux dans le cas où il faudrait, par suite des émanations, désinfecter les eaux. Enfin, la route menant à l'usine est empierrée et l'usine même est clôturée.

La dépense de cette installation s'est élevée :

Pour le terrain (1/2 hectare) à	fr. 7,250
Pour les constructions, y compris les tuyaux, les murs de soutènement, la route, les claies, l'outillage et la clôture à	» 6,430
Total, fr.	13,680

Si l'on ajoute les frais annuels, l'intérêt du capital et qu'on déduise le produit des ventes d'engrais, on arrive au chiffre de 0^e,05 par habitant.

Workshop, qui comprend une population de 7.000 âmes, possède une canalisation bien établie et quoique les *Water-Closet* ne soient pas aussi nombreux qu'il conviendrait, l'installation de M. Rawlinson pourrait être avantageusement imitée.

Rugby. — Avant que les liquides des égouts ne fussent utilisés pour l'arrosage, la municipalité de Rugby, pour faire cesser les plaintes causées par l'écoulement à la rivière de ces liquides, avait dû établir deux bassins de filtrage. Ces bassins construits sur les mêmes principes que ceux affectés à la clarification des eaux potables, ont marché trois ans sans donner de résultat ! Leur engorgement s'opérait si vite qu'à peine l'un des bassins était-il nettoyé, l'autre s'obstruait. Ils ont été remplacés depuis par de simples bassins de dépôt avec des claies de filtrage verticales.

Bingley. — Il nous reste à parler du mode de filtrage appliqué aux teintureries et blanchisseries de Bingley, et qui n'en offre pas moins un renseignement utile sur l'emploi des mâchefer. Les eaux grasses et savonneuses de ces usines filtrent à travers une couche de 4^m,30 à 6 mètres de mâchefer provenant des grilles des machines. Les parois du bassin sont elles-mêmes en mâchefer. Le dépôt de matières constitue un engrais excellent que l'on répand immédiatement sur les prés. Le liquide, au sortir des laveries, est amené dans des cuves en ciment, porté à l'ébullition par un jet de vapeur, traité par un acide qui fait coaguler à la surface le magma graisseux, puis écoulé dans les filtres à mâchefer d'où il sort très-limpide. Le magma est filtré sur des nattes de coco, garnies de toile, où il acquiert la consistance crémeuse, puis enveloppé dans des sacs en grosse toile, et porté à la presse où il abandonne près de 15 % de graisse. Les tourteaux sont très-estimés comme engrais.

Digues filtrantes. — L'installation de Workshop, qui repose sur le principe du dépôt des matières insolubles à l'aide d'une grande lenteur de circulation dans les bassins, remet en valeur le principe énoncé en 1827, et appliqué dans diverses circonstances, depuis cette époque, par M. Parrot, ingénieur des mines (1). Lorsqu'on établit un bassin de dépôt suivant les errements ordinaires, l'eau supposée épurée s'écoule par un déversoir de superficie, au fur et à mesure que l'eau à épurer afflue dans le bassin. Il est alors facile de remarquer que l'eau

(1) *Ann. des Mines*, 2^e série, t. IV et t. VIII.

ne se déplace à la surface que sur une épaisseur très-faible et forme une sorte de nappe courante dans laquelle les matières restent en suspension. Si, au contraire, pour faire écouler un même volume d'eau, on suppose que la digue qui barre le bassin, soit percée sur toute sa hauteur et sur toute sa largeur d'une foule de petits orifices, toute la masse d'eau qui remplit le bassin se mettra en mouvement, mais avec une vitesse qui sera en raison inverse de son épaisseur, comparativement à celle de la tranche mince qui formait le débit du déversoir de superficie. La vitesse devenue dix fois, cent fois plus faible, le dépôt des matières en suspension s'opère bien plus complètement.

M. Parrot a réalisé ce principe en grand, au moyen de digues faites en sable et gravier, perméables sur toute leur hauteur, c'est-à-dire garnies à diverses hauteurs de petits orifices à vannes. Mais en dehors de son application aux lavoirs à minerai de fer, le principe des digues filtrantes de Parrot ne s'est pas répandu.

On a récemment cherché à le faire revivre pour l'épuration des eaux de décharge aboutissant à la Seine. On proposait de faire arriver les égouts à de grands bassins de dépôt établis suivant le système Parrot et pouvant fonctionner alternativement. Un double jeu de vannes eut permis d'intercepter l'accès des bassins de dépôt et de rejeter directement les eaux dans le fleuve en cas de pluie abondante ou d'orage. Lorsque dans chaque bassin, le dépôt aurait atteint une épaisseur convenable, la vanne d'amenée serait fermée; le bassin serait vidé par décanation et la boue amassée sur le radier serait relevée à bras ou mécaniquement pour être séchée à l'air libre ou sous des abris. En ajoutant dans le canal d'amenée du charbon de tourbe que les environs de Paris fourniraient en abondance, on parviendrait, en condensant une partie de l'ammoniaque, à désinfecter les eaux et à augmenter notablement la valeur de l'engrais formant résidu. L'action de la tourbe est examinée dans le chapitre suivant, quant à celle des réservoirs Parrot envisagés isolément, elle ne représente dans notre pensée, qu'un moyen plus parfait, mais incomplet, d'augmenter la richesse agricole et d'améliorer les conditions générales de la salubrité.

Quoi qu'il en soit de la séparation mécanique des dépôts par filtration ou par repos, il ne faut pas oublier qu'elle exige l'emmagasinage temporaire d'énormes masses de matières, leur enlèvement très-prompt et un nombre considérable d'opérations qui demandent un personnel multiple et qui doivent s'exécuter autant que possible à distance des centres habités. La concentration sur un point unique du produit total des égouts d'une grande capitale comme Paris, serait par cela seul un obstacle des plus sérieux à l'établissement du filtrage. Nous croyons donc également difficile d'admettre, avec d'autres personnes, que les eaux de Paris pourraient être dirigées sous un collecteur voûté parallèle au fleuve, pour y laisser déposer les matières solides dans des puits placés de distance en distance. Un barrage établi sous un angle de 45° à l'embouchure du collecteur ferait dévier les eaux dans ce collecteur, dont la pente serait calculée de manière à faciliter le dépôt dans les puits. Au-dessus de chaque puits une noria, ou chaîne à godets, élèverait les matières solides et les déverserait soit dans des bateaux amarrés sur la Seine le long du collecteur, soit du côté de la route, dans des tombereaux. Ce projet n'est réalisable qu'à la condition que cette manipulation soit inodore et salubre, c'est-à-dire que les matières soient désinfectées, ou que le dépôt à peine extrait soit conduit non pas chez les consommateurs, car l'expérience des autres villes nous apprend qu'on l'enlève avec peine, même quand on le livre gratis, mais dans un dépôt général, où les mêmes questions d'assainissement se présentent.

2. — DÉSINFECTION.

Les procédés de désinfection reposent sur les propriétés chimiques absorbantes ou antiseptiques d'un grand nombre de substances susceptibles d'enlever aux liquides méphitiques leur couleur, leur odeur et de leur rendre leur limpidité. Ces substances appartiennent à plusieurs catégories.

1° Les oxydes métalliques et leurs sels, le sulfate de zinc, l'acétate et l'azotate de plomb, le pyrolignite de fer, le chlorure

de manganèse, les alcalis fixes, la chaux, la magnésie et leurs sels, etc. Ces composés fixent plus ou moins complètement les gaz contenus dans les eaux, notamment l'acide sulfhydrique, mais, sauf la chaux, l'alumine, la dolomie, les phosphates et le sulfate de fer, ils ne précipitent pas les matières insolubles, ni ne coagulent les matières dissoutes; ou bien, s'ils en séparent une partie, c'est à un état impropre à l'agriculture et en donnant aux liquides désinfectés des propriétés qu'ils n'avaient pas. La difficulté qu'on éprouve à se procurer ces réactifs en grandes quantités, leur prix de revient et les frais de manipulation ne permettent pas de les employer à l'épuration de volumes d'eaux aussi considérables que ceux des égouts d'une ville. Ils n'offrent donc, en dehors de ceux que nous signalons spécialement, qu'un intérêt médiocre.

Il convient toutefois de comprendre dans cette classe des composés d'une action chimique très-énergique, tels que le chlore, le chlorure de chaux, le perchlorure de fer, les acides sulfureux et nitreux, les sulfites alcalins, qui ont été appliqués sur une assez grande échelle; mais ces désinfectants sont ou d'un maniement trop délicat, d'une production trop restreinte, ou trop instables et, en tout cas, d'un prix trop élevé pour rentrer dans la pratique journalière.

2° Quelques substances anti-septiques; le goudron, le créosote, l'acide phénique et autres liquides brevetés, qui servent à retarder la décomposition de la matière azotée et à masquer les émanations. Mélangé aux sulfites alcalins, l'acide phénique constitue le fluide Mac-Dougall, employé dans certaines villes anglaises à l'épuration des eaux d'égout.

3° Enfin, la dernière catégorie de réactifs oxydants embrasse, d'une part, ceux qui accélèrent par leur oxygène la décomposition des éléments organiques, tels sont les permanganates alcalins, et, d'autre part, ceux qui par leur présence activent l'oxydation: tels sont l'argile et le charbon.

Nous nous bornerons à examiner les résultats fournis par les composés des deux dernières catégories, et nous réserverons pour le chapitre suivant les réactifs pouvant précipiter une partie des matières en suspension et en dissolution, tout en désinfectant les eaux.

Acide phénique. — Les propriétés anti-septiques de la créosote et du goudron de houille (*coal-tar*) sont connues de longue date. On a constaté récemment que ces propriétés étaient communes à leurs dérivés, la benzine et l'acide phénique. Ce dernier corps, dont l'eau, à la température de 15° à 18°, peut dissoudre 5 pour 100 de son poids environ, a déjà rendu des services importants, tant pour dissiper les miasmes que pour prévenir les effets de la fermentation putride. L'acide phénique ou carbolique découvert par Runge dans le goudron de houille, coagule l'albumine et empêche qu'elle ne devienne soluble, de même qu'il coagule le sérum et les autres matières organiques. Versé dans les eaux d'égout, il s'oppose au dégagement des gaz carbonique et sulfhydrique, car il prévient l'oxydation des matières et par suite leur décomposition.

D'après Angus Smith, il faut environ 60 grammes d'acide phénique par 300 personnes et par jour, pour désinfecter les égouts, soit une dépense annuelle d'environ 320,000 francs pour une population de 2 millions et demi d'habitants. La quantité d'acide se règle sur le poids de matières solides par litre et non pas sur le volume d'eau.

Un avantage que présenterait l'acide phénique, par rapport aux autres désinfectants inorganiques, c'est qu'à moins d'être employé à trop forte dose, il ne produit aucun effet nuisible sur les récoltes. Ainsi, les matières organiques, après avoir été traitées par ce corps qui les soustrait à l'oxydation à l'air libre, et une fois enfouies dans le sol qui absorbe l'oxygène atmosphérique, entrent de nouveau en décomposition.

Le fluide Mac Dougall proprement dit, consiste en un mélange de sulfite de chaux et d'acide phénique, il remplit, d'après son inventeur, deux objets importants: 1° il prévient toutes émanations malfaisantes et protège ainsi l'atmosphère des villes contre tous miasmes; 2° il accroît la valeur des liquides au point de vue agricole en s'opposant à la déperdition de l'ammoniaque.

A Carlisle, où les eaux des égouts conduites hors la ville par des canaux à ciel ouvert servent à l'arrosage d'une cinquantaine d'hectares de prés, M. Mac Dougall emploie avec succès depuis 8 ans, à la désinfection de ses eaux, un liquide tenant 2 % de

chaux et 1 % d'acide phénique. Le mélange préparé dans un réservoir spécial est écoulé lentement dans le puits où débouchent les eaux, avant leur épandage.

M. Fenton, ingénieur de la ville de Croydon, a rendu compte des essais de désinfection faits avec divers réactifs, entr'autres avec le fluide Mac Dougal. Le volume d'eau débité par le collecteur général était, par 24 heures, d'environ 3.200 mètres cubes en temps sec et de 6 à 7.000 mètres cubes en temps de pluie. Deux caisses en bois, enduites intérieurement de plâtre et d'une contenance de 2.000 litres chacune, servaient à préparer le mélange. On jetait dans l'eau de chaque caisse 10 kil. de chaux vive et 50 litres d'acide phénique. Le robinet de décharge placé à 0^m,04 du fond, permettait de ne soulever que le liquide surnageant. L'écoulement ne se faisait dans chaque caisse alternativement qu'autant que le liquide était bien clair. A partir de 8 heures du matin jusqu'à 5 heures de l'après-midi on descendait de 4 à 3 litres par minute; enfin on ne laissait plus couler passé 5 heures que 2 litres jusqu'à épuisement, au niveau du robinet, du contenu de la caisse que l'on remplissait d'eau immédiatement avec le mélange d'eau et d'acide.

La consommation pour 3200 mètres cubes d'eau d'égout était donc de

100 litres acide phénique
20 kil. chaux vive.

L'ouvrier étant libre à 5 heures, la main-d'œuvre était évaluée à 2^h,50 par jour.

Les eaux étaient parfaitement désinfectées.

En 1861, d'après M. Fenton, on consommait, 45 litres de phénate de chaux par jour valant 0^h,20 et représentant avec la main-d'œuvre 12 à 13 francs.

Les essais avec l'acide phénique n'ont pas eu de suite à cause de la trop forte dépense, et la ville de Croydon s'est décidée à filtrer ses eaux par des cloisons en briques et en tôles perforées, dans l'intervalle desquelles on entasse de la paille.

La précipitation des matières par le phénate de chaux, dépend de la proportion de chaux combinée, et sous ce rapport le mélange n'a pas d'effet comparable à celui obtenu avec la chaux ou

la magnésie seules. Quant à l'acide phénique isolément employé il masque les émanations sans en détruire le germe. Dans le fluide Mac Dougal, contenant des sulfites, outre le phénate de chaux, l'acide sulfureux exerce une action utile sur l'acide sulfhydrique et sur les matières azotées, mais il est si peu stable, qu'à moins d'être employé à forte dose, il cesse bientôt d'agir. D'ailleurs, le prix de ces sulfites les rend inabordable pour la désinfection en grand.

Permanganates. — Les manganates et les permanganates de potasse qui contiennent une forte proportion d'oxygène qu'ils abandonnent à la matière organique pour la détruire, constituent un désinfectant très-énergique, des plus précieux. Leur emploi a été breveté en Angleterre par M. Condry, qui livre au commerce des solutions titrées à des prix variables suivant le titre. Le Dr Letheby a constaté que 35 gouttes de la solution titrant 6 pour 100 environ de permanganate suffisent pour désinfecter complètement 1 litre d'eau d'égout de composition moyenne. L'action de ce réactif, comme celle du chlore, est permanente et égale, pour un même poids, à celle du chlorure de chaux; mais au prix où se vend la solution et en n'employant que 35 gouttes par litre, la dépense annuelle pour purifier les eaux des égouts de Londres atteindrait, d'après le Dr Letheby, 70 millions de francs!

Charbon. — Le pouvoir absorbant du charbon était connu par De Saussure, et depuis lui, il a reçu maintes applications, surtout dans la fabrication des engrais animaux dont il active la fermentation pour concentrer tous les gaz: ammoniac, hydrogène carboné et sulfuré, etc., de façon à les rendre inodores. Cette propriété a suggéré récemment au Dr Stenhouse l'emploi de caisses ou filtres à charbon pour désinfecter les gaz des égouts, avant qu'ils ne se répandent dans les habitations ou dans l'atmosphère (1).

M. Blyth a fait des essais très-importants sur le charbon de

(1) Rapport à la commission des Égouts, par le Dr Letheby, inspecteur médical et M. Haywood, ingénieur de la Cité. Londres, 1862.

tourbe et le coke de Boghead comme matières filtrantes. Les divers charbons essayés avaient la composition suivante :

	Carbone. p. 100.	Cendres. p. 100.	Nature des cendres.
Noir animal . . .	10,2	89,8	Phosphate et carbonate de chaux.
Charbon de tourbe	74,1	25,9	Silice, alumine et carbonates.
Coke de Boghead.	36,8	63,2	Silice principalement.

Ni le charbon de tourbe, ni le coke de Boghead ont une grande efficacité, quand on les mélange avec les eaux. Le premier se sature rapidement et tombe au fond, le second surnage pendant quelques semaines (quand il a été mis en poussière) et empêche toute émanation. Tous deux, après avoir été chauffés, rendent à l'atmosphère les gaz méphitiques qu'ils avaient absorbés.

Le charbon de tourbe absorbe près de 2 pour 100 en poids de gaz ammoniac et le coke 0,5 pour 100 seulement; de même, le charbon de tourbe peut absorber 4 fois plus de gaz sulfhydrique que le coke de Boghead.

Quant à leur action sur les matières dissoutes dans les eaux, voici les résultats obtenus en faisant passer 1000 parties en volume, d'eau des égouts de Tottenham (Londres) sur 1000 parties en poids des deux charbons.

	MATIÈRES EN DISSOLUTION		
	organiques.	minérales.	total.
Eaux naturelles, avant filtrage.	3,6	6,9	10,5
Id. après filtrage sur le charbon de tourbe . . .	3,1	9,4	12,5
Id. après filtrage sur le coke de Boghead	3,6	6,8	10,4

Ainsi, aucun de ces charbons ne sépare des matières en dissolution; au contraire, le charbon de tourbe en ajoute. Le charbon qui absorbe l'ammoniaque à l'état de gaz dans l'air, ne jouit pas de cette propriété, du moins à un degré utile pour l'ammoniaque en dissolution.

Une propriété très-précieuse, remarquée par M. Blyth, c'est que le coke de Boghead qui surnage sans se mélanger avec les liquides, en active considérablement l'évaporation, tout en condensant les gaz qui s'en échappent; de sorte qu'il est utilisable pour dessécher les produits.

MM. Hoffmann et Witt ont également expérimenté avec le charbon de tourbe. Dans deux caisses de même forme et de même contenance avec fond à claire-voie, recouvert d'une couche de gros gravier, on avait disposé dans l'une, une couche de sable de 0^m,30 d'épaisseur, dans l'autre, une couche de coke de tourbe de 0^m,30 également. Dès la mise en train des deux filtres, l'influence du charbon fut visible; car, tandis que l'eau filtrée sur le sable était trouble et odorante, bien qu'elle eût abandonné une partie des matières en suspension, l'eau filtrée sur le charbon était devenue limpide, incolore et à peu près inodore. Deux heures plus tard les différences étaient encore les mêmes; mais au bout de quatre heures, le liquide filtré sur le charbon était devenu trouble, tandis que l'autre avait conservé le même aspect.

Le filtre à sable avait reçu, 353 litres d'eaux d'égout, et le filtre à charbon, 367 litres.

Les résultats de l'expérience sont consignés dans le tableau suivant :

	MATIÈRES CONTENUES DANS UN LITRE		MATIÈRES SÉPARÉES DANS UN LITRE	
	minérales.	organiques.	minérales.	organiques.
Eaux d'égout avant le filtrage.	1,106	0,906	—	—
Id. après 2 heures de filtrage sur le charbon.	0,689	0,179	0,417	0,727
Id. après 4 heures. —	0,910	0,496	0,196	0,410
Id. après 2 heures de filtrage sur le sable .	0,730	0,458	0,376	0,448
Id. après 4 heures —	0,832	0,450	0,274	0,447

Il ressort de ce tableau que si le charbon est plus efficace dans le principe que le sable, il devient moins efficace après un certain temps, car son action décroît rapidement.

L'analyse du charbon avant et après le filtrage indique pour 100:

	Avant.	Après.
Azote.	2,032	= 2,467 ammoniacale.
Acide phosphorique. 0,55	0,120	= 0,260 phosphate de chaux.
Matière organique	95,72	94,069
Cendres	4,28	—

Par le brassage avec les eaux, le charbon de tourbe absorbe peut-être plus de matières que par le filtrage, mais son action est de moindre durée. A Croydon, où l'on avait essayé de mélanger les matières retenues par les filtres avec du charbon de tourbe, on n'obtint que des résultats négatifs comme enrichissement de l'engrais.

Filtres d'Uxbridge. — Le Conseil municipal d'Uxbridge, contraint à ne laisser décharger les égouts dans la rivière Colne qu'après en avoir épuré les eaux, fit établir en 1857 un grand bassin voûté où les eaux déposent, puis s'écoulent dans des caisses remplies, sur une épaisseur de 0^m,90, de charbon de tourbe en morceaux de 0^m,07 à 0^m,10. Le dépôt du bassin s'élève à l'aide de rails par une porte située à l'une des extrémités et s'étend en couches peu épaisses sur le sol de l'usine, où on le recouvre de poussier de charbon, de cendres ou d'argile, pour le vendre ensuite aux fermiers des environs. Ce premier essai n'ayant pas réussi à désinfecter les eaux de la rivière, un second procès fut intenté et un second bassin voûté fut construit. La surface des filtres a été portée à 15 mètres carrés par bassin; ce qui est encore insuffisant. La dépense annuelle en charbon s'élève à 1750 fr.; la main-d'œuvre à 1500 fr.; soit au total à 3,250 fr. Les filtres sont nettoyés environ toutes les semaines. L'engrais sec, mélangé avec les cendres et balayures de la ville est livré à 6 fr. la tonne, et la quantité vendue avec peine, varie annuellement entre 180 et 200 tonnes. Comme le charbon une fois saturé

perd son action oxydante, il n'agit plus à Uxbridge que comme matière filtrante, et à ce titre il pourrait être avantageusement remplacé par des scories, des cailloux ou du gravier.

Argile et sable. — La propriété désinfectante de l'argile est mise à profit depuis des siècles. En Chine, on mélange avec les matières fécales un tiers en poids environ d'argile grasse, on pétrit le tout en gâteaux qui forment pour toutes les grandes villes, sous le nom de *tafo*, un important objet d'exportation.

A Ely (comté de Cambridge) M. Burns, ingénieur de la municipalité, a appliqué l'argile à la désinfection des eaux des égouts. Avec une tonne d'argile il pouvait désinfecter 600 mètres cubes de liquide; mais il calculait que pour des liquides très chargés de matières azotées, il en fallait le double. Les eaux des égouts débouchant dans le puits collecteur rencontraient un filet d'eau argileuse venant d'un bassin supérieur et entraient dans un réservoir où elles se filtraient *per ascensum* à travers une couche de sable et de charbon de bois. La matière déposée dans ce réservoir et dans le filtre était recueillie dans des bacs contenant un mélange d'argile en poudre sèche et de charbon de tourbe ou de cendres. Les gaz méphitiques du puits étaient appelés par un foyer où ils se brûlaient. La chaleur de ce foyer servait en outre à dessécher l'argile et le charbon destinés au mélange des bacs. Depuis 1860, M. Burns a combiné l'emploi de la chaux avec l'argile et nous décrivons sa nouvelle installation pour la ville d'Ely dans le chapitre suivant.

L'action du sable comme matière filtrante et absorbante est notoire. Nous avons indiqué (p. 33) les résultats comparatifs des expériences faites par M. Hoffmann sur un filtre à sable et un filtre à charbon. Les grandes Compagnies des eaux potables à Londres, recourent à des lits de cailloux, de gravier et de sable, disposés suivant un certain ordre, à travers lesquels les eaux filtrent sous une pression variable. Les dispositions de ces filtres dans lesquels le sable ne joue pas qu'un rôle mécanique, mais bien celui d'absorbant des gaz, ont dû être abandonnées partout où elles ont été essayées pour les eaux d'égout, car au bout d'un temps très-court, la couche de vase qui engorge le sable ne livre plus passage aux eaux.

Désinfection par le sol. — D'ailleurs, la faculté d'absorption de l'argile et du sable est attestée par celle du sol. Les cimetières de chaque ville reçoivent des quantités énormes de matières organiques avant que les émanations ne soient sensibles. Les exemples que nous citerons de l'application des eaux d'égout à l'arrosage d'une même surface pendant plus de cent ans, confirmeront ces résultats, aussi surprenants par la rapidité avec laquelle les gaz sont fixés, que par la perfection de ce mode d'épuration. En effet, les terres arables n'agissent pas seulement comme les matières poreuses pour condenser l'ammoniaque et les autres gaz, mais elles ont la propriété de décomposer beaucoup de sels, outre les sels ammoniacaux. Cette action sur les composés salins, indiquée et expliquée par divers auteurs, a été l'objet de travaux remarquables de la part de MM. T. Way et A. Voelcker. M. Way opérant sur des sols de composition connue, avec ou sans matières organiques, renfermant, l'un des traces de carbonate de chaux, l'autre 6 pour 100, les a traités respectivement par des dissolutions concentrées d'ammoniaque, de carbonate, de chlorhydrate, de sulfate d'ammoniaque; de carbonate, d'azotate et de sulfate de potasse; de chaux, de bicarbonate et de biphosphate de chaux; de magnésie, etc. Il a reconnu que ces sels se décomposaient pour les premières portions, en filtrant à travers une épaisseur de 0^m,50 des sols essayés. Les alcalis restent, et on retrouve seulement dans le liquide filtré les acides, azotique, chlorhydrique et sulfurique combinés avec une certaine quantité de chaux ou de magnésie. L'ammoniaque et la potasse sont absorbés ainsi que l'acide phosphorique (1).

Le Dr Voelcker a vérifié ces résultats en déterminant les échanges de nature diverse qui ont lieu entre les éléments du sol et ceux des sels dissous. Quelques-unes des conclusions de son mémoire sur les propriétés chimiques des sols, méritent d'être rapportées ici, parce qu'elles donnent la clef des résultats observés dans l'emploi des engrais liquides (2).

(1) *Journal of the Royal Agric. Soc. of England*, t. XI, 1850.
(2) Id. id. t. XXI, 1860.

Les sols employés aux essais avaient la composition suivante, d'après l'analyse mécanique :

	TERRES				
	calcaire.	sableuse fertile.	argileuse forte.	sableuse stérile.	à pâturage.
Eau	1,51	-	3,91	-	2,42
Matière organique et eau de combinaison.	11,08	4,38	4,80	5,36	11,70
Carbonate de chaux	10,82	-	-	-	-
Chaux, magnésie, potasse, etc.	-	1,37	2,19	0,23	1,54
Argile	52,06	18,09	78,13	4,57	48,39
Sable	24,53	76,16	10,97	89,82	35,95
	100,00	100,00	100,00	100,00	100,00

Tous les sols jouissent de la faculté d'absorber l'ammoniaque en dissolution dans l'eau; les sols sableux en absorbent autant que les sols argileux; ceux des terres à pâturage, riches en matières organiques, en retiennent moins que les sols plus pauvres; mais la différence d'absorption entre les différentes variétés est moindre qu'on ne le croit généralement. Quelque faible que soit la solution, l'ammoniaque n'est pas entièrement fixée, il en passe toujours dans le liquide filtré. Aucun sol ne peut fixer entièrement l'ammoniaque; bien que les solutions faibles soient relativement plus épuisées et bien qu'un sol, après avoir enlevé à une solution faible la plus grande partie de l'ammoniaque, puisse en absorber de nouveau au contact d'une solution plus forte.

Indépendamment de l'ammoniaque, les sols enlèvent ce corps en certaine quantité aux dissolutions de sels ammoniacaux. Si l'on fait passer une solution de sel ammoniac ou de sulfate sur un sol, l'ammoniaque seule est absorbée et les acides car-

bonique et sulfurique filtrent après s'être combinés avec la chaux ou avec les autres matières minérales.

Dans aucun cas, l'ammoniaque n'est fixée d'une manière assez complète et assez permanente, pour empêcher que l'eau n'en dissolve de nouveau une portion. Mais cette portion est très-faible par rapport à celle qui est fixée.

Le liquide, après filtrage des solutions de sels ammoniacaux, contient une plus forte proportion de matières minérales que si l'on eut fait passer seulement de l'eau pure.

Des eaux d'égout après filtrage à travers certains sols argileux tenant de la potasse, renfermaient plus de potasse qu'avant d'être filtrées, et la même quantité d'acide phosphorique.

Ces résultats, nous le verrons, sont confirmés par l'application en grand des arrosages.

3. — PRÉCIPITATION.

Les agents susceptibles de précipiter les matières solides contenues dans les eaux d'égout ont été déjà énumérés. La plupart ont été essayés, mais un petit nombre seulement ont résisté à l'épreuve de la pratique industrielle. A part la chaux, qui est encore généralement appliquée dans la plupart des villes où l'on désinfecte les eaux d'égout, des sels, tels que les phosphates de chaux et de magnésie, l'alumine, le sulfate d'alumine et le perchlorure de fer n'ont donné lieu qu'à des applications expérimentales.

Quoi qu'il en soit, leur action repose, pour tous également, sur la coagulation et la précipitation des matières en suspension; de sorte que des eaux putrides, visqueuses, incapables de s'épurer par le repos, acquièrent momentanément un certain degré de limpidité et alors ne répandent plus dans l'atmosphère des gaz méphitiques.

Nous décrirons d'abord les expériences faites avec ces réactifs, puis les applications tentées dans diverses localités, le plus souvent dans le but de réduire les dépenses, par la vente de l'engrais résultant de la précipitation.

Chaux.

Expériences de Manchester. — Ces expériences furent entreprises en 1856, sous la direction de MM. A. Smith, Calvert et Mac Dougall, pour purifier les eaux de la rivière Medlock. La chaux était mélangée à l'aide d'agitateurs mécaniques, dans des bassins spéciaux. Pour les eaux les plus chargées, 20 kilogrammes de chaux suffisaient à l'épuration complète de 100 mètres cubes; et pour les eaux moins chargées, 12 kilogrammes de chaux donnaient un bon résultat. Afin de diminuer la consommation de chaux, on essaya de traiter par de la chaux ayant déjà servi, une nouvelle quantité d'eaux, et on parvint en augmentant suffisamment la dimension des réservoirs à ne plus employer que 3 kilogrammes de chaux par 100 mètres cubes. Les eaux qui contenaient en moyenne 0^m,17 de matières solides par litre, n'en renfermaient plus après l'épuration que 0^m,05. Les eaux, bien que limpides, avaient néanmoins une légère odeur qui augmentait par le repos.

Expériences sur les eaux des égouts de Londres. — 1. MM. Hoffmann et Witt ont traité ces eaux à raison, de 0^m,285 de chaux par litre. La chaux avait été éteinte préalablement avec 0^m,50 d'eau d'égout. Après une heure, le liquide était devenu assez clair; mais après 3 heures de repos, il était encore louche. La totalité des matières en suspension n'avait pas été précipitée, et les matières déposées n'étaient pas entièrement dépourvues d'odeur. D'ailleurs, la chaux paraît plus efficace quand les eaux ont été récemment recueillies.

MATIÈRES PAR LITRE.

	minérales.	organiques.
Eaux d'égout après épuration. . .	0 ^m ,794	0 ^m ,375
Proportions de matières précipitées. .	0,223	0,691

Le dépôt analysé donna :

Pour 100.

Azote.	1,55 = 4,88 ammoniaque.
Acide phosphorique. . .	2,93 = 6,33 phosphate de chaux.
Matière organique . . .	43,95

En rapportant le prix de ces éléments à ceux du guano valant 275 fr. la tonne, MM. Hoffmann et Witt évaluaient à 48 fr., la tonne de dépôt provenant de ces eaux, exceptionnellement chargées de matières.

2. M. Way a repris ces essais et il a constaté que 20 à 22 kil. de chaux suffisaient pour désinfecter 100 mètres cubes d'eaux d'égout. Les analyses suivantes reproduisent les résultats du traitement des eaux de l'égout de Northumberland, puisées en mars 1839.

	MATIÈRES PAR LITRE		
	avant l'épuration.	après l'épuration.	précipitées.
Matière organique { soluble .	0 ^{gr} ,2770	0 ^{gr} ,2760	0 ^{gr} ,505
{ insoluble .	0 ,5580	-	
Chaux	0 ,1445	0 ,1320	0 ,213
Magnésie	0 ,0202	0 ,0134	0 ,003
Soude	0 ,0570	0 ,0322	0 ,014
Potasse	0 ,0522	0 ,0542	
Chlorure de sodium	0 ,3766	0 ,3494	0 ,016
Acide sulfurique	0 ,0562	0 ,0854	
Id. phosphorique	0 ,0375	0 ,0064	0 ,029
Id. carbonique	0 ,1284	0 ,0740	0 ,127
Silice, oxyde de fer, etc. . . .	0 ,0884	0 ,0032	0 ,085
Ammoniaque	1 ^{gr} ,8160	1 ^{gr} ,0202	0 ^{gr} ,992
	0 ,100	0 ,107	0 ,040

Il résulte de ces analyses :

1^o Que la chaux ne précipite que la matière organique insoluble, qu'une simple filtration eût séparée.

2^o Que l'ammoniaque contenue dans le précipité provient uniquement de la matière organique insoluble, et que la chaux ne fixe aucune partie de l'ammoniaque soluble.

3^o Que la potasse soluble n'est pas fixée.

4^o Que les 5/6^{es} de l'acide phosphorique sont précipités.

Le traitement des eaux par la chaux n'ajoute donc aucun élément fertilisant, à l'exception de l'acide phosphorique, au dépôt séparé par simple filtrage. D'ailleurs, ce dépôt desséché a la composition suivante :

Matière organique (1)	50,95
Chaux	21,30
Magnésie	0,36
Acide carbonique	12,83
Acide sulfurique	1,60
Acide phosphorique	3,10
Sable, etc.	9,86
	100,00

Il faut, en outre, tenir compte de 10 pour 100 d'eau, ce qui diminue d'autant la valeur agricole de ce produit.

Phosphate de magnésie.

Le procédé de Sir James Murray consiste à séparer, par l'addition du superphosphate de magnésie, l'acide phosphorique et l'ammoniaque des eaux d'égout, à l'état de phosphate ammoniac-magnésien. Or, ce sel est loin d'être insoluble, car il se dissout dans 45000 parties d'eau pure et dans 7000 parties seulement d'eau tenant des sels ammoniacaux. Dans les eaux des égouts de Londres, où l'analyse accuse la présence par litre de 0^{gr},0265 d'acide phosphorique à l'état soluble et de 0^{gr},0028 à l'état insoluble, on n'obtiendrait que 0^{gr},06 de sel ammoniac-magnésien. Or, cette quantité de sel ne peut se déposer dans un litre d'eau susceptible d'en dissoudre 0^{gr},15. Il ne se fait donc aucun précipité.

On a proposé de diminuer l'action dissolvante de l'eau d'égout en y ajoutant de l'ammoniaque libre, mais alors il faudrait dépenser 40 francs d'ammoniaque pour extraire l'acide phosphorique de 1 mètre cube d'eau d'égout, soit pour obtenir 0^{gr},80 de phosphate.

(1) Contenant 4,03 d'ammoniaque.

Les essais que MM. Blanchard et Château ont répétés avec l'acide phosphorique obtenu par leur procédé, sur les eaux d'égout à Londres n'ont eu, par cette raison, aucun résultat.

Phosphate de chaux et de magnésie.

M. Way, se conformant au brevet Blyth, a traité 1 mètre cube d'eaux de l'égout de Northumberland (Londres) par une quantité de superphosphate (phosphate de chaux soluble) correspondant à 450 gr. d'acide phosphorique, et par 270 gr. de sulfate de magnésie. Il ajouta ensuite assez d'eau de chaux pour précipiter le tout. Les résultats de ce traitement sont consignés dans le tableau ci-après :

	MATIÈRES PAR LITRE		
	avant l'épuration.	après l'épuration.	précipitées.
Matières en suspension . .	0 ^{er} ,3476	0 ^{er} ,4828	0 ^{er} ,5745
organiques en dissolution . .	0 ,1754		
Chaux	0 ,1786	0 ,3018	0 ,3673
Magnésie	0 ,0228	0 ,3553	0 ,0336
Soude	0 ,0343	0 ,0723	
Potasse	0 ,0472	0 ,0542	0 ,0184
Chlorure de sodium	0 ,4884	0 ,4683	
Acide sulfurique	0 ,0912	0 ,0547	
Acide phosphorique	0 ,0353	0 ,1706	0 ,3084
Acide carbonique	0 ,1677	0 ,0713	0 ,0873
Sable, silice, oxyde de fer, etc.	0 ,0921	0 ,0214	0 ,1159
	1 ^{er} ,0814	2 ^{er} ,5817	1 ^{er} ,5054
Ammoniaque	0 ,112	0 ,110	0 ,059

Ainsi, tandis qu'un tiers de l'acide phosphorique reste dans le liquide filtré, la petite quantité d'ammoniaque fixée n'est due qu'à la matière organique en suspension.

M. Way a analysé le précipité :

Matière organique (1)	38,09
Chaux	24,32
Magnésie	2,23
Acide phosphorique	20,15
Acide carbonique	5,79
Silice, sable, oxyde de fer, etc.	9,12
	100,00

Sulfate d'alumine.

La précipitation par le sulfate d'alumine, mélangé avec la chaux s'opère très-rapidement; c'est là le caractère distinctif des sels d'alumine(2), mais le liquide renferme encore des matières organiques et n'est pas désinfecté. MM. Hoffmann et Witt ont constaté les résultats de ces deux réactifs par l'analyse (3) :

	MATIÈRES PAR LITRE	
	minérales.	organiques.
Eaux avant l'épuration	1 ^{er} ,018	1 ^{er} ,266
Id. après l'épuration	0 ,716	0 ,536
Matières séparées	0 ,302	0 ,730
Composition du précipité :		
Azote	1,21	= 1,44 ammoniaque.
Acide phosphorique	3,97	= 8,60 phosphate de chaux.
Matière organique	35,97	

(1) Contenant 2,24 d'ammoniaque.

(2) Nous avons déjà rendu compte de l'emploi de l'argile et des schistes alumineux pour la désinfection des eaux vannes en Chine (page 35). En Égypte, on a recours de longue date à l'alun pour clarifier les eaux limoneuses du Nil. — Suivant d'Arcet (*Annales des Ponts et Chaussées* 1836, t. XI), 0^{er},50 d'alun par litre suffisent pour rendre ces eaux limpides au bout d'une heure. — D'après Genieys (*Annales id.*, t. IX, 1835), avec 10^{er} par hectolitre, l'effet est immédiat. On continue à expédier annuellement d'Angleterre des quantités notables de ce sel pour la clarification des eaux potables, tant en Australie qu'en Égypte, etc.

(3) Ces chimistes n'indiquent pas les proportions de sulfate d'alumine et de chaux employées.

M. Way a recommencé ces essais, d'après le brevet Stothert, en ajoutant au sulfate d'alumine et à la chaux un peu de sulfate de zinc et du charbon de bois. Pour 1 mètre cube d'eau, il employa 1 kilogramme sulfate d'alumine, 50 grammes sulfate de zinc et 1 kilogramme charbon de bois en poudre. Après avoir brassé ces matières, on introduisit dans le liquide 300 grammes de chaux éteinte. Les résultats de l'opération sont rapportés dans le tableau ci-dessous :

		MATIÈRES PAR LITRE		
		avant traitement.	après traitement.	précipitées.
Matières	en suspension .	0 ^{re} ,2425	0 ^{re} ,3078	1 ^{re} ,7353
organiques	en dissolution .	0,5858		
Chaux		0,2098	0,3026	0,1920
Magnésie		0,0259	0,0258	0,0117
Alumine		—	0,0109	0,1418
Oxydes de zinc et de fer		0,0376	0,0143	0,1266
Soude		0,0342	0,0322	
Potasse		0,0509	0,0533	
Chlorure de sodium		0,3225	0,3210	0,0071
Acide sulfurique		0,0713	0,4576	
Acide phosphorique		0,0821	traces	0,0552
Acide carbonique		0,1272	"	0,1208
Silice		0,1555	0,0035	0,1502
Ammoniaque		1,9450	1,5290	2,5407
		0,120	0,119	0,485

Ces résultats diffèrent peu de ceux du traitement à la chaux; le précipité a seulement perdu de sa valeur par suite de l'addition d'une quantité notable de charbon et d'alumine. La totalité de l'acide phosphorique y est toutefois précipitée, sans doute, à l'état de phosphate d'alumine.

La composition pour 100 du précipité est indiquée comme suit :

Matière organique (1)	68 ^{re} ,29
Chaux	7,11
Magnésie	0,46
Alumine	5,56
Oxydes de fer et de zinc	4,98
Acide phosphorique	2,47
Acide carbonique	4,75
Silice, etc.	6,68
	100,00

Chlorure de chaux

Le chlore et ses composés oxygénés agissent en se combinant avec l'hydrogène des gaz et aussi peut-être, en décomposant l'eau; cette décomposition met alors en liberté l'oxygène qui détruit les miasmes. Labarraque avait constaté le premier, l'énergie du chlorure de chaux pour la désinfection des liquides et des atmosphères limitées; ce composé est entré depuis dans l'usage journalier. Le Dr Letheby a vérifié sur les eaux d'égout le pouvoir désinfectant du chlore et du chlorure de chaux. Ainsi 0^{re},10 de chlorure ou 5 à 6 grammes d'une dissolution de chlore, suffisent pour enlever toute émanation à 1 litre d'eau d'égout.

En admettant qu'on n'emploie que 0^{re},10 de chlorure de chaux par litre, il faudrait dépenser annuellement près de 5 millions de francs pour purifier les eaux de la ville de Londres. Le prix du chlorure le met donc hors de cause.

Perchlorure de fer.

Quand on verse du perchlorure de fer dans les eaux d'égout, il se forme un précipité qui se dépose rapidement. Ce précipité, qui consiste surtout en peroxyde de fer, n'est pas dû, comme pour les agents précédemment indiqués aux acides, mais aux

(1) Renfermant 1,89 d'ammoniaque.

bases des sels préexistant ou en formation dans le liquide. Il renferme à peu près la totalité de l'acide phosphorique des eaux et l'acide sulhydrique à l'état de sel insoluble, mais peu ou point de matière organique et d'ammoniaque en dissolution.

L'emploi du perchlorure de fer, qui remplit donc aussi parfaitement que possible le but de la désinfection instantanée, ne répond pas d'une manière aussi satisfaisante au programme agricole. Ainsi, d'une part, précipitation rapide, fixation stable de l'hydrogène sulfuré, séparation très-nette des matières solides sans décomposition des liquides. D'autre part, un dépôt de phosphate de fer et de sels alcalins, sans azote, pouvant servir de base à une fabrication d'engrais, mais ne constituant pas par lui-même un engrais.

L'action du perchlorure de fer est démontrée, d'ailleurs, par les nombreuses expériences de MM. Hoffmann et Frankland et de M. Way.

MM. Hoffmann et Frankland chargés par le Conseil métropolitain d'indiquer parmi les nombreux projets qui lui étaient adressés, un procédé à la fois efficace et économique de désinfecter les matières des égouts, ont fait porter leurs investigations sur la chaux, le chlorure de chaux et le perchlorure de fer. La conclusion de leurs recherches est que la désinfection peut être effectuée par l'un ou l'autre de ces agents, mais qu'en prenant des quantités de valeur égale, le perchlorure de fer l'emporte d'une manière marquée sur les deux autres, et que le chlorure de chaux est plus puissant que la chaux, non-seulement comme action immédiate, mais comme permanence d'effet produit.

A l'issue de l'égout de *King's Scholar's Pond*, on fit construire des bassins en briques, rendus étanches par du ciment et pouvant contenir plus de 30 mètres cubes de liquide. Une pompe à vapeur introduisait les liquides dans les bassins et les divers réactifs y étaient incorporés soit graduellement, pendant le remplissage, soit en les versant après coup dans la masse liquide et les brassant mécaniquement. D'un nombre suffisant d'expériences ainsi conduites, il résulte que chacun des trois réactifs opère une désinfection immédiate de 30 mètres cubes de liquide, quand on les applique dans les proportions suivantes :

Perchlorure de fer (1). . .	2 ⁰⁰ ,25	soit par 1 ^m cube	0 ^m ,065
Chlorure de chaux . . .	1 ⁴⁰ ,35	» »	0 ^m ,040
Chaux	36 ⁰⁰	» »	1 ^m ,100

D'après les prix de chacun de ces produits, un millier de mètres cubes d'eau exigeait comme dépense de désinfection :

65 ⁰⁰ par le perchlorure de fer.	96 ⁰⁰ ,25
40 ⁰⁰ par le chlorure de chaux	11 ⁰⁰ ,88
110 ⁰⁰ par la chaux.	18 ⁰⁰ ,45

Pour juger de la permanence de la désinfection, trois quantités égales de matière ont été recueillies et traitées respectivement par le perchlorure de fer, le chlorure de chaux et la chaux. Après désinfection parfaite, on a laissé reposer. Après deux jours, le liquide désinfecté par la chaux, commençait à répandre de l'odeur, tandis que celui traité par le chlorure de chaux était parfaitement inodore. Après trois jours, le liquide à la chaux était nauséabond; tandis que les deux autres liquides étaient sans odeur. Après quatre jours, le liquide à la chaux dut être rejeté; celui au chlorure de chaux commença à se corrompre. Le liquide au perchlorure de fer était complètement inodore, même après le long intervalle de neuf jours.

Un autre élément important dans l'estimation de la valeur relative des agents, est le temps nécessaire pour la clarification. Sous ce rapport, le perchlorure de fer a encore l'avantage.

En supposant que le traitement soit appliqué par le perchlorure de fer, à la totalité des eaux recueillies dans les réservoirs de Barking Creek et de Crossness Point (Londres), MM. Hoffmann et Frankland ont calculé que pendant la saison la plus chaude de l'année, environ trois mois, la dépense s'élèverait à environ 300,000 francs.

Des calculs fondés sur d'autres expériences permettaient à la Commission de 1861 d'évaluer à 75 francs la dépense journalière.

(1) MM. Hoffmann et Frankland n'indiquent pas la teneur en fer de ce sel, qu'ils emploient à l'état de solution concentrée (*Muriate de fer de Dolez*); mais il est probable qu'ils entendent ici le sel à l'état sec.

lière nécessaire à l'épuration par le perchlorure de fer de 5000 mètres cubes d'eaux d'égout, sans tenir compte des frais d'exploitation (1).

D'après M. Way, il faudrait de 20 à 40 grammes d'une solution de perchlorure tenant 25 p. 100 de sel pour clarifier et désinfecter complètement 100 litres d'eaux des égouts de Londres; soit de 5 à 10 grammes de perchlorure solide, ce qui représente environ le chiffre désigné par MM. Hoffmann et Frankland.

La solution de perchlorure qui a servi à M. Way à traiter 1000 litres d'eaux des égouts de Croydon contenait 25 pour 100 de ce sel, correspondant à 8,60 de fer métallique. Les résultats de l'analyse avant et après le traitement ont été :

	MATIÈRES PAR LITRE	
	avant le traitement.	après le traitement.
Matière organique	0,1312	0,1398
Chaux	0,1604	0,1223
Magnésie	0,0193	"
Soude	0,0299	"
Potasse	0,0155	"
Chlorure de calcium	"	0,0613
— de magnésium	"	0,0432
— de sodium	0,0706	0,1321
— de potassium	"	0,0248
Acide phosphorique	0,0092	traces.
Acide sulfurique	0,0489	0,0508
Acide carbonique	0,0680	0,0245
	0,5590	0,5088
Ammoniaque	0,0331	0,0332

(1) *Second Report of the Commission on Sewage*, London 1861.

Ainsi cet agent, d'après ces essais, ne sépare pas de matière organique ni l'ammoniaque contenue dans les eaux d'égout.

On a essayé à Croydon, qui représente une ville moyenne, pourvue d'une bonne distribution d'eau et d'une canalisation récente, le traitement des eaux par le perchlorure. La quantité maximum de ce sel, 20 grammes, était employée entre 9 et 11 heures du matin, et entre midi et 2 heures, à d'autres heures l'eau était relativement peu chargée et 6 grammes suffisaient. Toutefois, la dépense étant trop forte, la ville a dû abandonner l'usage de ce réactif (1).

Le perchlorure de fer est, en effet, un sel coûteux, que l'on ne peut actuellement se procurer en grandes quantités. M. Way propose de le fabriquer industriellement avec du sel commun, de l'oxyde de fer et de l'acide sulfurique mélangés en proportions équivalentes, de façon à ce qu'il y ait assez de chlore pour se combiner avec le fer et assez d'acide sulfurique pour se combiner avec la soude. Si l'opération est bien conduite, il se perdra peu d'acide chlorhydrique; le produit est une substance dure, jaunâtre et non déliquescence, dont le prix de revient s'établirait ainsi, en prenant pour base, par exemple, les prix de Marseille :

Sel marin	10 ¹	à 14 ¹	. . . 140 ¹
Acide sulfurique	8,36	— 70	. . . 585
Oxyde de fer	7,60	— 30	. . . 228
Houille	6, »	— 25	. . . 150
Main-d'œuvre 35 jours	—	4	. . . 140
Frais généraux à raison de 15 fr. par tonne de produit et amortissement			210
			Total, 1453 ¹

(1) Les résultats des essais de M. Way et de M. Croydon sont en contradiction avec les expériences du D^r Koene, entreprises devant une Commission spéciale à Bruxelles, le 17 janvier 1863. Quelques gouttes de perchlorure de fer mélangées à de l'eau recueillie dans l'égout de la rue du Rempart-des-Moines, à Bruxelles, produisent, après quelques minutes, une précipitation presque complète des matières et le liquide clair qui surnage est désinfecté. M. Heyvaert, chimiste, chargé d'analyser les ma-

soit fr. 1433 pour 14 tonnes de perchlorure de fer solide, ou environ 100 francs la tonne. La valeur du sulfate de soude cristallisé ne peut pas entrer en compte, car il serait toujours souillé par du fer et impropre aux verriers. Le chiffre de la main-d'œuvre est basé sur celui de la fabrication de la soude brute, ainsi que celui du charbon; ce dernier devra être augmenté, si l'on considère qu'il faudra évaporer, après le dépôt du sulfate de soude hydraté, les lessives de perchlorure.

Si l'on employait à la désinfection le produit brut qui, dans le traitement proposé par M. Way, ne renferme que 26 pour 100 de perchlorure, il faudrait dépenser au moins 30 francs par tonne de ce produit.

Il est possible que le perchlorure solide puisse être livré à des prix plus bas, surtout si, d'après M. Boblique, on l'obtenait comme résidu du traitement du phosphore de fer par le chlore, pour l'extraction du phosphore. Jusque-là, il n'y a pas lieu de compter sur un emploi plus étendu de ce désinfectant, d'autant plus que le précipité ne peut avoir comme engrais qu'une valeur restreinte, vu sa nature ferrugineuse.

Sels divers.

On a cherché à traiter les eaux par divers mélanges des réactifs énumérés : chaux, phosphate, acide de chaux, dolomie, chlorures alcalins, en les introduisant successivement dans les eaux, en prolongeant plus ou moins la durée de leur action, en forçant les doses; sans qu'on ait réussi à fixer plus d'azote que n'en fixe la chaux employée seule, et sans que les eaux soient entièrement clarifiées. Quoi qu'on ait tenté, le sulfate d'ammoniaque reste dans les eaux et se perd, tandis que le produit

tières précipitées, aurait trouvé 0,40 pour 100 d'azote et 30 de phosphate de fer; il estime la valeur de l'engrais à 100 francs la tonne. En se fondant sur ces expériences, le Dr Koene n'a pas craint de proposer de se charger de désinfecter les eaux provenant des collecteurs avant de les rendre à la Seine, moyennant 20,000 francs par an, et la disposition des engrais ainsi produits.

solide ne renferme que 30 pour 100 de l'azote total des eaux. L'addition du perchlorure de fer permet seul de faire disparaître immédiatement le trouble; mais la question de prix ne laisse pas entrevoir que cet emploi combiné avec la chaux, par exemple, puisse entrer dans la pratique.

IV. — APPLICATIONS DES PROCÉDÉS D'ÉPURATION.

Cheltenham. — Cheltenham offre l'exemple d'une des applications les plus économiques du traitement des eaux d'égout par la chaux. Les dispositions adoptées ont été reproduites, avec quelques modifications seulement, par les villes de Coventry, de Stroud, de Chelmsford, etc.

Les égouts de la ville de Cheltenham, dont la population de 40,000 âmes est répartie sur une surface de 1200 hectares, débouchent sur deux points opposés où l'on a construit deux établissements pour l'épuration des eaux. Le principal établissement (pl. 2.) consiste en un bâtiment divisé sur sa longueur en deux séries de bassins qui fonctionnent alternativement. Ces bassins sont établis dans le sous-sol. Les eaux passent des bassins supérieurs aux bassins inférieurs, à travers des filtres verticaux où elles abandonnent la plupart des matières en suspension. Les filtres ont 1^m,50 de profondeur et 0^m,60 d'épaisseur; ils sont formés de gros gravier resserré entre des planches perforées de 0^m,05 et recouvertes de claies qui empêchent l'obstruction.

Les matières les plus lourdes tombent au fond, mais une grande partie reste à l'état flottant et n'est séparée que par la cloison du troisième bassin dans lequel on traite le liquide par la chaux. Dans le canal qui sert d'émissaire à ce dernier bassin on ajoute une nouvelle quantité de chaux et le liquide traverse un filtre de gravier, puis un second filtre de gravier plus fin avant de déboucher finalement dans la petite rivière Chelt.

Quand le dépôt s'est élevé à la hauteur voulue dans les bassins, on détourne les eaux dans l'autre série, ce qui a lieu tous les deux mois environ. On lave alors le gravier des filtres en

chômage et on opère le curage à l'aide de seaux que l'on élève au-dessus du plancher des bassins, au niveau du sol. Les seaux sont vidés dans des brouettes et les brouettes sont culbutées dans des tas de cendres, de boues et d'autres débris provenant du nettoyage de la ville, que l'on a préalablement disposés en forme de cuvettes. La pâte fluide est presque aussitôt solidifiée; car le mélange se fait au rable au fur et à mesure qu'une nouvelle brouette est amenée sur le tas. On fait ainsi absorber aux cendres et aux boues sèches jusqu'à deux tiers de leur volume de matières fluides. Le produit annuel atteint de 2,000 à 2,500 mètres cubes d'engrais solide et sec.

La dépense en chaux est d'environ 20 francs par semaine. Le bâtiment de l'usine principale a coûté 30,000 fr. Le volume d'eau traité est de 1500 mètres cubes par 12 heures. Les cendres, boues, etc., coûtent 0,80 le mètre cube. La main-d'œuvre par mètre cube d'engrais est de fr. 2,50 à fr. 2,70.

Jusqu'en 1857, le Conseil municipal avait fixé la valeur de l'engrais à 3 francs le mètre cube; mais par suite de la consommation toujours croissante, on éleva le prix alors à fr. 4,50 qui couvrait les frais de l'établissement. Plus tard, afin d'écouler promptement le produit, on dut revenir au prix primitif.

Cette fabrication ne donne lieu à aucune plainte dans le voisinage. Dans nos fréquentes visites, pendant notre résidence de deux années à Cheltenham, nous n'avons remarqué aucun dégagement, ni dans les eaux écoulées, ni dans les matières brassées sur le sol de l'usine. Notre ami, M. Dangerfield, ingénieur de la ville, qui avait construit cette usine et adopté à notre instigation le traitement à la chaux, se proposait d'ajouter des réservoirs où les eaux se seraient dépouillées des dernières parties de chaux en suspension avant d'être rejetées à la rivière. Nous ignorons si ce perfectionnement a été apporté depuis la mort de M. Dangerfield.

Coventry. — A Coventry, les eaux du bassin de dépôt s'échappent latéralement, à travers un filtre de gros gravier de 0^m,60 d'épaisseur, dans un second bassin de plus petites dimensions, puis, à travers un deuxième filtre, dans un troisième bassin où l'on ajoute de la chaux. Bien que l'état de la rivière

se soit beaucoup amélioré depuis la création de cet établissement, les liquides des égouts à cause des dimensions trop petites des bassins et de la faible consommation de chaux, ne sont pas encore assez complètement désinfectés. Du reste, ces liquides sont exceptionnellement chargés de matières solides dues au lavage des laines et aux teintureries.

Les bassins qui forment deux séries ne sont pas surmontés de bâtiments comme à Cheltenham, mais simplement voûtés et le pavé de niveau avec le sol, porte un tramway sur lequel circule une petite grue roulante qui sert à manœuvrer les seaux au-dessus de chaque regard. L'atelier et le dépôt de chaux sont situés à l'extrémité du réservoir transversal.

L'ingénieur, M. Greateux, établit de la manière suivante le prix de la construction et les dépenses annuelles.

Prix d'acquisition du terrain (1 ^h 00 ^m ,6) et de	
construction de la voie	fr. 13,900
Constructions diverses	» 94,100
	Fr. 108,100
Intérêt du capital à 6 p. 100	» 6,480
Frais d'exploitation (moyenne de 3 années). »	4,300
	Fr. 10,780

à déduire :

Quantité moyenne d'engrais vendus (1122	
tonnes plus 600 ^e en magasin) au prix de. »	2,800
Reste, fr.	7,980

ce qui constitue par habitant une charge de 0,185, pouvant descendre, par la vente de la totalité de l'engrais, à 0,14.

Stroud. — L'établissement de Stroud est éloigné de toutes habitations, de sorte que les bassins sont à ciel ouvert. Du premier bassin de dépôt, les eaux du collecteur se rendent, à travers une digue diagonale de pierres et de cailloux, dans un deuxième bassin d'où elles sortent latéralement par deux filtres de gravier de 0^m,90 d'épaisseur chacun, et débouchent dans le bassin de défécation. Le lait de chaux préparé sous un hangar

latéral tombe dans le liquide au sortir des filtres. Un dernier filtre sépare le précipité avant l'écoulement à la rivière.

Les deux séries de bassins construits par l'ingénieur M. Taunton, ont coûté 28,000 francs. Les eaux sont chargées, comme à Coventry, des substances provenant du désuintage des laines, des draperies et teintureries qui font de la ville de Stroud un centre manufacturier important. Malgré cela, l'engrais précipité est peu recherché.

Chelmsford. — L'émissaire à Chelmsford est à un niveau trop bas pour que les eaux puissent filtrer par leur pente naturelle. On a utilisé, en conséquence, les machines déjà installées pour la distribution des eaux potables. L'arbre de ces machines commande deux pompes de 33 centimètres qui puisent les eaux dans un puits de 3^m de profondeur et les déversent dans une conduite en fonte de 0^m,30 aboutissant, à 300 mètres de distance, à des réservoirs dont le radier est à la cote de 3 mètres au-dessus de l'émissaire. Les pompes marchent de 6 heures du matin à 7 heures du soir, quel que soit le débit du collecteur.

D'après les calculs de M. Chancellor, ingénieur, ce débit varie entre 800 et 1000 mètres cubes par jour.

Comme il y a une double rangée de bassins, on y dirige alternativement le courant des eaux. En A (pl. 3), un petit mur barre le passage aux matières lourdes; en B, le liquide tenant les matières en suspension rencontre une série de plaques de tôle perforées qui arrêtent encore une partie des matières solides. En C, se trouvent des filtres de toiles perforées, écartées de 0^m,60, entre lesquelles on tasse du mâchefer. De ces filtres, le liquide est amené par trois tuyaux sur un point où coule un filet d'eau de chaux. Le mélange s'opère dans le second compartiment et, après précipitation, les eaux entrent dans un filtre horizontal C' formé de plaques perforées, recouvertes d'une couche de mâchefer de 0^m,46 d'épaisseur, où le filtrage a lieu de bas en haut. Le liquide qui surnage coule limpide à la rivière.

Une rangée de bassins fonctionne pendant six ou huit semaines; dès que le dépôt atteint, dans le premier compartiment, une épaisseur de 0^m,45 on fait fonctionner l'autre rangée. Avec une pompe à main, on enlève autant de liquide que possible

dans les compartiments en vidange. Autour de chacune des vannes H, H, de la paroi latérale, on forme un talus avec les débris des chaussées, boues, cendres, etc.; et au fur et à mesure que la pâte fluide s'écoule par une vanne, on l'incorpore avec ces matières.

La quantité d'engrais vendu annuellement ne dépasse guère 400 tonnes. Le prix a été abaissé de 3 fr. 75 à 3 fr. sans que la consommation ait augmenté sensiblement.

Les dépenses de construction se sont élevées à 30,000 fr. : pompes, conduites, bassins et filtres, mais non compris les machines déjà installées pour les eaux potables, ni le terrain.

Les frais annuels se décomposent ainsi :

Un manoeuvre, à 15 fr. par semaine	fr. 780
Combustible, fr. 8,75 id.	" 455
Chaux, pendant l'été	" 200
	Soit fr. 1,435

non compris les frais d'entretien.

Enfin la recette annuelle est de

400 mètres cubes d'engrais à fr. 3,10	fr. 1,240
moins	
200 mètr. cub. de cendres, boues, etc., à fr. 1,25.	" 250
	fr. 990

En tenant compte de l'intérêt du capital remboursable en 30 ans, l'épuration des eaux de la ville de Chelmsford représente, d'après l'ingénieur de la ville, une charge annuelle de 0,30 par habitant.

Bien que la chaux ne soit employée que pendant la saison d'été et que les eaux, au sortir du compartiment à la chaux, pourraient être utilement déversées dans un autre bassin de dépôt avant d'être filtrées, l'installation de Cheltenham, imitée à Coventry, à Stroud et à Chelmsford, paraît résoudre écono-

miquement le problème hygiénique. Au point de vue agricole, l'engrais composé de débris, cendres et boues de la ville, ne gagne pas beaucoup en valeur par l'addition des matières déposées ou précipitées dans les eaux d'égout. Mais on parvient aisément à se débarrasser de ce compost dans un rayon de quelques kilomètres; ce qui n'est pas le cas avec les matières non mélangées des filtres.

On comprendra, d'après cette remarque, l'insuccès des procédés qui ont pour but la fabrication d'un engrais complet exclusivement avec les seules matières solides des eaux d'égout, et notamment des procédés Higgs et Wicksteed, que nous allons décrire.

PROCÉDÉ HIGGS. — M. Higgs proposait, devant la Commission parlementaire de 1846, d'établir, à l'issue des collecteurs, trois réservoirs couverts, d'une capacité suffisante pour contenir chacun le volume maximum des eaux débitées pendant douze heures. Une vanne ouvre ou intercepte à volonté toute communication entre les réservoirs et le collecteur. Sur un tramway longitudinal, un wagonnet rempli de chaux ou de tout autre réactif à l'état pulvérisé ou fluide, circule et déverse son contenu, par un regard, dans chaque bassin. Après l'introduction de la chaux, les produits volatils, tels que l'ammoniaque et l'hydrogène sulfuré, sont appelés dans une chambre supérieure où, en présence du gaz chlore, ils forment du soufre et du chlorhydrate d'ammoniaque.

Le précipité, après avoir séjourné quelques heures dans le bassin, est mis à sec par décantation ou par épuisement; recouvert de plâtre ou de toute autre substance susceptible de se combiner avec l'ammoniaque et les autres gaz, puis comprimé ou séché artificiellement.

Deux des bassins sont affectés au traitement des eaux pendant douze heures; le troisième aux crues exceptionnelles.

M. Higgs, sans avoir encore appliqué son procédé, attribuait une valeur de 100 francs par tonne à l'engrais obtenu; en même temps qu'il faisait valoir l'innocuité des eaux rejetées et des gaz répandus finalement dans l'atmosphère.

En 1849, une usine, d'après le système Higgs, fut établie sur

l'un des principaux collecteurs de la cité, à Londres; mais elle ferma deux années plus tard. Une autre usine, à Cardiff, eut le même sort.

Tottenham. — Enfin, la ville de Tottenham (10,000 habitants) traita avec une Compagnie chargée d'appliquer ce procédé. L'usine construite par la Compagnie se composait d'un bassin de 200 mètres cubes dans lequel s'écoulaient les eaux du collecteur; d'une machine à vapeur de 8 chevaux (cylindre 0^m,25; course, 0^m,40) qui élevait les eaux dans 4 réservoirs en tôle de 50 mètres cubes chacun.

Un lait de chaux était versé dans le liquide à son entrée dans les réservoirs, puis mélangé à l'aide d'agitateurs. On employait une partie de chaux pour quatre parties de matières solides. Ces matières, d'après M. Higgs, représentaient 1/500^e du volume liquide; la proportion de sable n'y figurait que pour 1,5 pour 100.

Les réservoirs remplis, on laissait le dépôt s'effectuer pendant une demi-heure et on écoulait le liquide. Le précipité n'était extrait qu'après sept ou huit opérations successives.

Les gaz dégagés, surtout pendant le curage des réservoirs, étaient appelés au contact du chlore, dans une chambre supérieure.

Aucun des procédés adoptés pour dessécher le précipité ne réussit. En dernier lieu, on essorait le fluide dans un tambour tournant avec une grande vitesse, d'où le produit tombait sur une série de plaques chauffées par un foyer spécial.

Le prix de l'engrais fixé d'abord à 400 francs, puis à 50 et enfin à 25 fr. la tonne, ne trouva pas de débouché. L'usine fut fermée après deux années de travail et la ville, en 1861, la racheta à la C^e pour le dixième de sa valeur. On se borne aujourd'hui à retirer ce dépôt des réservoirs et à épurer par la chaux les liquides décantés, avant de les perdre dans la rivière Lee.

A **Luton**, où une autre usine avait été établie primitivement, d'après le système Higgs, on filtre les liquides et on emploie une roue hydraulique pour élever les eaux au sortir du collecteur, de même que pour les agiter mécaniquement avec le lait de chaux.

PROCÉDÉ WICKSTEED. — Les brevets de M. Wicksteed datent de 1834 et de 1856; fondés sur les mêmes réactions que celles indiquées par M. Higgs, ils sont de beaucoup postérieurs aux brevets de ce dernier.

Leicester. — Après un essai sur les eaux d'un collecteur correspondant à une population de 5000 individus, le procédé Wicksteed fut appliqué, en mai 1855, à Leicester, ville de 65,000 âmes. Le Conseil municipal, obligé par décision supérieure de désinfecter les eaux des égouts, avant de les jeter à la rivière Soar, avait traité avec la *C^e Solid Sewage Manure*, lui abandonnant la totalité des eaux, à la condition que cette *C^e*, à ses risques et périls, fit les travaux nécessaires pour les élever et les désinfecter. La canalisation de la ville venait d'être terminée et amenait au collecteur de 4 à 5 millions de mètres cubes par an, d'eaux assez riches, par suite de l'industrie du tissage qui constitue l'élément principal de la prospérité de Leicester.

La *C^e* s'établit à 1 kilomètre et demi au-dessous de la ville, sur le bord de la Soar.

Le collecteur y débouche dans un puits; une machine à vapeur de 20 chevaux (cylindres 0^m,63; course 2^m,35) élève les eaux par une pompe de 0^m,70 de diamètre au niveau des réservoirs. Une autre petite pompe, commandée par la même machine, verse dans la conduite-maitresse alimentée par la première pompe, une certaine quantité de lait de chaux préparé dans une citerne spéciale. Cette quantité réglée par des robinets, varie entre 0^m,25 et 0^m,005 par litre, suivant la nature des eaux et la consistance du lait. Des agitateurs à palettes brassent le mélange dans une caisse étroite et longue d'où le liquide sort lentement, par des ouvertures horizontales, dans un réservoir en maçonnerie de 60 mètres de longueur sur 13 mètres de largeur, divisé en deux compartiments, à une distance de 15 mètres du point de départ, par une série de châssis verticaux et mobiles. Ces châssis en toile métallique sont destinés à retenir les corps en suspension. La vitesse du liquide, qui n'est plus que de 0^m,006 à 0^m,008 par seconde, permet aux sept-huitièmes environ du dépôt floconneux de se déposer dans le premier compartiment. Dans la partie comprise entre les agitateurs et les châssis, le

réservoir est recouvert d'une voûte plate formant plancher. Le radier est formé de deux parties inclinées vers le milieu, où elles se réunissent en une rigole, dans laquelle une vis d'Archimède de 0^m,90 de diamètre entraîne la pâte vers un puisard. La profondeur du réservoir est ainsi de 1^m,50 le long des parois, et de 4^m,50 au milieu.

À l'aval, des petits diaphragmes, ou vannes, laissent le liquide épuré s'écouler par tranches minces à la rivière.

Une chaîne à godets élève les boues du puisard dans une des deux citernes situées à l'étage supérieur, à 6 mètres au-dessus du sol. Comme à Tottenham, la difficulté consistait à débarrasser ces boues du liquide en excès. M. Wicksteed s'est arrêté à l'emploi d'essoreuses à force centrifuge qui enlèvent les deux tiers de son poids d'eau à 200 kil. de matière, après un quart d'heure de révolution. Cesessoreuses, au nombre de 12, font 1000 tours par minute.

Plus tard, pour diminuer la dépense de ce mode de séchage, M. Wicksteed employait une presse consistant en une série de plateaux à toile métallique et placée à l'étage inférieur.

La pâte, au sortir de la presse ou des toupiesessoreuses, était découpée, moulée à l'état de briquettes, et mise à sécher.

Une machine de 8 chevaux mettait en mouvement les agitateurs, la vis et la noria. Chaque toupie était conduite par une petite machine horizontale à cylindre oscillant. Une seule chaudière fournissait la vapeur à ces diverses machines. Le personnel de l'usine comprenait, outre le mécanicien et le chauffeur, 3 ouvriers auxessoreuses, 1 briquetier, 5 ou 6 manœuvres.

La *C^e*, en 1856, avait dépensé, tant en installations qu'en essais, une somme de 700,000 fr. pour traiter annuellement 5 millions de mètres cubes d'eau, d'où elle extrayait en moyenne 4500 tonnes d'engrais solide. Le prix, fixé en 1856, à 50 fr. la tonne, dut être baissé de moitié en 1857, sans plus de résultat au point de vue de la vente de l'engrais. En 1858, la *C^e*, en présence d'un stock considérable, abandonnait son usine à la municipalité, qui s'est bornée depuis à faire épurer les eaux à la chaux, sans traiter la matière solide.

Quelques éloges qu'ait mérités l'installation de Leicester que

l'on a été jusqu'à comparer à celle de la sucrerie indigène, l'échec commercial du procédé Wicksteed a ses raisons :

1^o L'opération reposait sur la vente à un prix élevé d'un fertilisant renfermant moitié de son poids de chaux et un quart seulement de l'azote total existant dans les eaux ; encore, cet azote était-il à l'état insoluble. Ainsi, l'analyse faite par le D^r Voelcker sur les briquettes, n'indiquait que 0,60 pour 100 d'azote égal à 0,72 d'ammoniaque et 0,25 pour 100 de phosphate (1). Il est utile de reproduire cette analyse en regard de celle de M. Hervé-Mangon (2).

ANALYSE DE M. VOELCKER.		ANALYSE DE M. H. MANGON.	
Eau	11,52	Eau	12,00
Matière organique (3)	12,46	Produits volatils	19,65
Silice insoluble	13,50	Résidu insoluble	13,25
Carbonate de chaux	52,99	Chaux	45,75
Oxyde de fer et alumine	2,89	Alumine, phosphate et fer	8,25
Carbonate de magnésie	3,67	Magnésie	traces
Sulfate de chaux	1,76	Azote	1,10
Chlorure de sodium	0,45		
Potasse	0,27		
Phosphate de chaux	0,27		100,00
	99,77		

D'après son analyse, M. Mangon considère l'engrais de Leicester comme équivalent à 2,750 kil. de fumier frais dosant 0,4 p. 100 d'azote, ou bien à 73^e,3 de guano dosant 15 p. 100 d'azote. Et comme le guano valait 300 fr. les 100 kil., l'engrais Leicester

(1) *Metrop-Drainage*, July, 1857.

(2) *Ann. des Ponts et Chaussées*, 1856.

(3) Azote = 0,60 = ammoniaque 0,72.

devait valoir 22 francs ; en faisant abstraction toutefois des frais de transport considérables et du mode d'action différent de ces fertilisants. Or, l'analyse du D^r Voelcker lui assigne la moitié de cette valeur au point de vue de l'ammoniaque ; d'ailleurs l'ammoniaque, nous l'avons démontré (1), n'est pas le seul élément qui détermine la valeur d'un engrais et l'expérience des agriculteurs a suffi pour prouver l'inefficacité de l'engrais Wicksteed, au prix même de 10 fr. la tonne.

2^o L'opération était grevée de frais beaucoup trop considérables, en égard au résultat définitif. M. Wicksteed a publié l'état des dépenses faites pendant l'année 1858 (2), d'où il ressort que, pour traiter 4,800,000 mètres cubes d'eau, soit 13,000 mètres cubes environ par 24 heures, ou 200 litres par jour et par habitant, il avait été payé pour

500 tonnes de chaux fr. 9,250
Main-d'œuvre pour l'extraction et le mélange de la chaux » 1,950
Combustible » 650
Main-d'œuvre aux machines, outillage, etc. » 1,900

Total, fr. 13,750

soit 0^e,21 par an et par habitant, ou 0^e,30 par 1000 mètres cubes d'eaux épurées. Mais il n'est tenu aucun compte de l'intérêt du capital dépensé, ni des frais d'entretien, ni de la fabrication des briquettes, ni du travail des essoreuses, etc. Les chiffres posés par M. Wicksteed ont donc été non-seulement dépassés, mais il est inadmissible, comme il l'a proposé, de songer à traiter les eaux d'une population de 500,000 âmes avec un capital de 1 million de francs, pour en extraire un engrais valant de 3 à 5 francs la tonne.

Les éloges n'ont pas manqué au procédé Wicksteed comme résultat hygiénique, bien que les émanations fussent souvent sensibles aux abords de l'usine, et que les eaux écoulées à la

(1) *Fabrication et emploi des phosphates de chaux, en Angleterre*.

(2) *Lettre au Times*, 19 mars 1860.

rivière continssent plus des trois quarts de l'ammoniaque total. Ces éloges auraient été plus justement décernés à l'ensemble des travaux d'assainissement de la ville. Les poissons ont pu revenir, depuis l'application du procédé Wicksteed, dans les eaux de la Soar, d'où la corruption des eaux d'égout les avait chassés, mais ce résultat a été obtenu ailleurs par des dispositions beaucoup moins coûteuses que celles de Leicester.

Dans notre opinion, l'application de Leicester, dont on avait songé à recommander l'adoption pour des villes importantes, fournit l'argument le plus sérieux contre l'idée sans cesse mise en avant de retirer des eaux d'égout un engrais solide, ayant une valeur commerciale ou agricole.

Aujourd'hui, on se borne, à Leicester, à pomper les eaux et à les épurer moyennant une dépense annuelle de 30 à 35,000 fr. Les grosses eaux se rendent directement à la rivière. Plus de 5000 maisons sont en communication directe avec les égouts; et les nouveaux collecteurs reçoivent les eaux des autres maisons par les anciens égouts. Parmi les établissements on compte 10 teintureries et 230 usines. L'engrais se vend 2 francs le mètre cube (1); ce qui est loin du compte de M. Wicksteed.

Dans d'autres localités, on a traité les eaux par la chaux additionnée d'autres sels.

Bristol. — M. Blackwell, ingénieur, chargé par l'administration du *workhouse* (hospice) de Clifton, de purifier les liquides de cet établissement, a essayé pendant quelque temps d'un mélange de sulfate de fer et de chaux. Dans un bassin de 50 mètres cubes environ, il faisait verser la chaux, puis après agitation, le sulfate de fer. Dans un second bassin, les eaux étaient abandonnées au repos avant de couler à la rivière Froome. Le mélange s'opérait deux fois par jour; chacun des deux réservoirs se vidant une fois par 24 heures. L'installation a coûté 15,000 fr.; la consommation de réactifs a été de 200 kil. de chaux et de 120 kil. de

(1) *Report on Sewage*, 1866.

vitriol par semaine. Les frais se sont élevés annuellement, y compris le combustible nécessaire à une petite machine à vapeur de 2 chevaux, à fr. 2,350
auxquels il convient d'ajouter l'intérêt et l'entretien, soit 1,100

Fr. 3,450

Le curage des réservoirs a lieu tous les mois, mais le vitriol étant nuisible à la vente de l'engrais, on n'emploie plus, depuis 1860, que de la chaux.

Ely. — Dans l'usine d'Ely, reconstruite en 1860 (voir page 35), le lait d'argile mélangée de chaux coule d'une manière continue dans le conduit qui amène les liquides du collecteur et les rejette sur un filtre monté sur galets qui peut glisser haut et bas dans une chambre rectangulaire élevée, servant à la fois de cheminée pour la ventilation (pl. 4). Lorsque la caisse-filtre est remplie de pâte fluide, on la monte par un treuil jusqu'à l'étage supérieur où se trouve le séchoir, et on la remplace aussitôt par un autre filtre que l'on descend au-dessous du niveau de l'émissaire. Le séchage consiste en un mélange de la matière fluide avec 2 parties de charbon de bois, 1 partie de plâtre et 4 de boues ou cendres sèches.

On recueille par cette disposition la plus grande partie de la matière précipitée avant qu'elle n'entre en décomposition; de sorte que l'eau, dans les bassins à filtrer, ne fermente plus aussi rapidement. Le filtrage ultérieur a lieu *per ascensum* à travers trois couches 1^{re} de plâtre en morceaux (0^m,15 d'épaisseur); 2^e de charbon de bois (0^m,30 d'épaisseur); de plâtre fin (0^m,15). Les filtres *ee* ainsi établis, qui représentent une surface de 2 à 3 décimètres par litre de liquide, durent six mois sans être renouvelés. Le charbon provient de la sciure de bois calcinée.

L'engrais Burns se vend 12^s,50 la tonne, mais les agriculteurs se plaignent de ce qu'il est trop complètement désinfecté.

PROCÉDÉ STOTHERT. — Ce procédé, qui a donné lieu aux expériences consignées page 43, a été appliqué pendant bien des années à l'un des principaux collecteurs de Londres, dans le Strand, sans donner lieu à aucune plainte de la part du voisinage; toutefois il n'a pas trouvé d'imitateurs par les raisons que nous avons données.

PROCÉDÉ HERAPATH. — Le brevet Herapath consiste à traiter les eaux par un mélange de sulfate de fer et de dolomie calcinée. Il a été appliqué pendant quelque temps à St-Thomas, près d'Exeter, dans les bassins construits par la ville à la sortie du collecteur principal. En employant 1 de vitriol et 4 de dolomie, l'inventeur évaluait la dépense par tonne, y compris la main-d'œuvre, le combustible, etc., à 21 francs. Une tonne de matières fournissait 2 tonnes d'engrais sec. L'entrepreneur, faute de capital, dut renoncer à l'application du brevet, et la ville a finalement adopté l'épuration à la chaux.

PROCÉDÉ MANNING. — Ce procédé, appliqué à Edimbourg et à Liverpool, repose sur l'action combinée des schistes aluminifères, du sulfate de fer et du noir animal. Ces agents, employés à proportions égales, représentent une dépense de 9 fr. par tonne. Le mètre cube d'eau est désinfecté au prix de 0^e.025. L'engrais, d'après les analyses du Dr Penny, de Glasgow, est très-efficace et la désinfection est parfaite; mais ce procédé n'est utilisable que pour des établissements publics ou particuliers.

PROCÉDÉ DOVER. — D'après le brevet Dover, les eaux sont traitées par l'acide chlorhydrique, le sel marin et le sulfate de fer, puis filtrées sur du plâtre, du charbon ou de l'argile que l'on incorpore finalement avec le précipité. Nous ignorons si ce brevet a reçu quelque application en grand.

V. — IRRIGATION PAR LE SYSTÈME TUBULAIRE.

Il reste à examiner la solution la plus importante du problème posé : l'utilisation des eaux des égouts ou mieux leur désinfection par le sol. Cette application, qui a reçu la consécration de plusieurs siècles dans certaines localités, n'a été reprise que dans ces dernières années, grâce aux progrès de la chimie et de la physiologie, grâce aussi aux observations des agriculteurs éclairés.

L'engrais liquide ou purin des étables et des écuries, connu en Suisse sous le nom de *gulle*; en Allemagne, de *mist-wasser*, et dans le nord de la France, sous le nom

de *lisier*, est, de longue date, recueilli dans des citernes souterraines où il fermente, puis répandu sur le sol, soit à la main à l'aide d'écopes, soit avec des tonneaux.

L'emploi des vidanges fraîches, encore aujourd'hui l'objet de grands préjugés, se pratique également d'ancienne date dans les départements de la Flandre, en Alsace, dans le Dauphiné et en Italie.

Enfin, dès le moyen-âge, la Vettabia a recueilli les eaux des égouts de Milan, pour en féconder des vastes prairies, et cette même méthode introduite, depuis plus d'un siècle, aux environs d'Edimbourg, permet de fertiliser des terres autrefois sans valeur.

Ces divers exemples de l'application de l'engrais liquide ne s'étaient guère généralisés, bien que les recherches physiologiques eussent démontré que la végétation s'active d'autant plus que le sol fournit aux plantes une plus grande quantité de substances assimilables. On finit toutefois par en conclure que les éléments immédiatement solubles dans l'eau étaient plus facilement assimilés : de là, la pensée de ramener les engrais à l'état liquide et de les répandre, en profitant de cet état physique qui facilite le transport et l'épandage sur le sol.

En 1839, M. Chadwick, secrétaire du premier *Board of Health*, proposait, comme Fellenberg l'avait pratiqué trente ans auparavant pour l'arrosage des prairies par infiltration, de faire circuler les liquides des égouts et des vidanges, à travers des tuyaux de poterie, de manière à fertiliser la couche inférieure du sol arable. Smith de Deanston, qui avait fait, avec assez de succès, des essais sur l'emploi des matières fécales fraîches, visitait, en 1844, les prés de Craigtenny, à Edimbourg, et comme membre du *Board of Health*, suggérait, de son côté, l'emploi des eaux d'égouts de toutes les villes. Ses calculs l'amenaient à croire que le revenu assuré par cette irrigation suffirait non-seulement pour couvrir les dépenses d'une canalisation plus complète des égouts, mais encore pour exécuter, sans charges nouvelles, la plupart des autres travaux d'assainissement.

Smith proposait d'arroser « à l'aide de tuyaux ajustés bout

» à bout et munis d'une lance à l'extrémité, sous une pression
» de 40 mètres de hauteur, partout où l'irrigation ne pouvait
» se faire par les moyens connus. » Dans sa pensée, l'engrais
liquide des villes possédait la moitié de la valeur du guano
et représentait une somme de 25 francs par habitant et par an.

Ces hypothèses, ces appréciations si l'on veut, avaient un aspect de vraisemblance séduisant dont M. Chadwick s'empara aussitôt pour développer une théorie sans doute entachée d'exagération, mais qui se résumait ainsi : « L'engrais liquide, dans toutes les circonstances, est préférable à l'engrais solide; il est applicable avec avantage à toutes les cultures et à tous les sols. De même que les villes, qui perdent journellement des milliers de mètres cubes d'eaux chargées de principes fertilisants, toutes les exploitations agricoles doivent recueillir dans des réservoirs les déjections, les résidus et les matières organiques, les y mélanger avec l'eau dans la proportion de 1 à 4 fois le volume d'engrais solide. Une machine élévatoire refoulera le liquide jusqu'à un réservoir supérieur d'où partira un réseau de tuyaux souterrains d'un diamètre suffisant pour alimenter des tuyaux mobiles et flexibles, terminés par une lance et servant à l'aspersion des récoltes. »

Cette théorie coïncidait avec un ensemble d'efforts les plus louables pour l'assainissement par le drainage, c'est-à-dire en assurant la double circulation alternative de l'air et de l'eau à travers le sol. Là où l'empirisme et le hasard avaient procédé à l'arrangement des conduits souterrains, les promoteurs du mouvement sanitaire conseillaient aux agriculteurs l'établissement, suivant une pente régulière, de drains communiquant avec la surface sur la plus grande partie de leur parcours et débouchant finalement dans un fossé collecteur, de façon à développer, par les agents atmosphériques, la fertilité du sol, et à rendre possible les rotations fondées sur l'alternance des meilleures cultures fourragères. Le drainage, qui régularise le régime des eaux, qui assainit l'atmosphère, est le complément indispensable de l'irrigation; il enlève l'eau, tandis que celle-ci l'amène; il supprime à la fois les eaux pluviales stagnantes

et les eaux torrentielles. Aussi, l'arrosage n'est-il possible qu'à la condition que le sous-sol soit drainé.

Le système tubulaire, c'est ainsi qu'on était convenu de l'appeler, devint l'objet de publications nombreuses de la part du *Board of Health* et des organes de la presse acquis au progrès agricole. Des instructions détaillées réglaient les dispositions à prendre pour assurer le succès de cette innovation. Le programme du *Board of Health* était complet : distribution des eaux pures dans les villes ou dans les habitations, perte immédiate des déjections et des eaux infectes dans les égouts ou dans les bassins, arrosage par aspersion des terres en culture.

Les applications du système tubulaire ont été nombreuses. Depuis, elles ont été citées, notamment celles des fermes de l'Ecosse et du nord de l'Angleterre, dans maints Rapports et dans maints Traités d'agriculture, à l'appui des théories émises. Mais, il faut le constater, aucune de ces exploitations rurales n'a tenu les brillantes promesses que le système avait fait concevoir; leurs propriétaires ont dû peu à peu abandonner ou modifier l'arrosage par aspersion. M. James Kennedy, qui a donné son nom au système en France, après avoir immobilisé un capital considérable dans la ferme Myer Mill (Ayrshire) célèbre par ses récoltes exceptionnelles de Raygrass, a disparu de la scène. Bien que son successeur paye un fermage plus élevé que le sien et continue, dit-on, à arroser par le système tubulaire, il n'a pas à faire entrer en compte l'intérêt du capital dépensé dans cette somptueuse installation. M. Telfer, de Canning Park, a fait faillite, malgré les soins extrêmes apportés à tous les détails et à la comptabilité de sa ferme, et malgré la prime dont ses produits jouissaient jusques sur le marché de Londres (1). M. Robert Neilson a quitté la ferme de Halewood, près de Liverpool, pour remplir un emploi d'inspecteur de drainage. M. Huxtable, dont les savantes publications sur l'infériorité de l'engrais solide, avait vivement impressionné le

(1) On a payé jusqu'à 0,10 de plus la livre de beurre expédiée d'Ecosse à Londres par M. Telfer.

public, fut obligé peu à peu de restreindre à deux ou trois hectares de prairies, la distribution des engrais liquides étendue d'abord à toute la ferme de Sulton Waldron (Dorsetshire). Dans la ferme de M. Chamberlaine, luxueusement installée d'après les avis de M. Mechi, pour l'arrosage tubulaire, les conduites ont été relevées et vendues au prix de la vieille ferraille. M. Littledale, à la ferme de Liscard, près de Birkenhead, n'arrose plus que le ray-grass nécessaire aux vaches de sa laiterie, et, depuis longtemps, il a repris pour les autres récoltes, céréales et racines, la fumure au guano et au superphosphate. Reste l'Alderman Mechi, dont le zèle pour l'agriculture est digne de tous éloges, mais qui, après avoir préconisé outre mesure les résultats du système tubulaire appliqué sur 70 hectares de sa ferme de Tiptree Hall (Essex), s'est finalement rangé aux procédés de culture pratiqués anciennement par ses voisins du Norfolk. L'engrais liquide n'est plus employé à Tiptree que pendant la saison sèche, et sur une surface de 6 hectares, principalement en prairie. On conçoit qu'une canalisation correspondant à une dépense de 370 à 500 francs par hectare, servant uniquement à l'arrosage de 6 à 8 hectares dans un pays où il pleut 150 jours par année, n'indique pas un esprit de sage économie. Aussi, M. Mechi, ne tenant aucun compte du capital immobilisé en matériel inutile, n'a-t-il pas cessé de recourir au fumier, au guano et aux autres engrais commerciaux pour assurer ses récoltes.

En France, quelques applications d'arrosage par les engrais liquides dans l'Orne, le Pas-de-Calais, etc., ont été abandonnées. La ferme de Vaujours, exploitée depuis 1837 par M. Moll, pour l'épandage des vidanges de Paris par le système tubulaire, a passé en d'autres mains, malgré la subvention et les marques de vif intérêt données par la ville de Paris et le ministre d'agriculture. La Société de Vaujours a dépensé un capital de 200,000 francs en essais infructueux sur environ 90 hectares, et s'est liquidée, sans pouvoir affirmer la supériorité du système tubulaire et de l'engrais liquide.

Ainsi, les théories de M. Chadwick qui substituaient à la fumure ordinaire l'emploi exclusif, pour toutes les récoltes, de

l'engrais liquide, ont été successivement jugées par la pratique. Nous n'insisterons pas sur ce qu'elles avaient d'ingénieux, ni sur les services incontestables rendus par leurs promoteurs, et, pour ne pas sortir du cadre de notre travail, nous nous contenterons de décrire les applications du système tubulaire avec les eaux des égouts; elles sont limitées, du reste, à quelques localités.

COMPAGNIE MÉTROPOLITAINE.

Cette Compagnie s'était fondée en 1845 sous les auspices de MM. Martin et Smith de Deanston « pour conduire les » eaux des égouts de Londres et les distribuer par des » tuyaux, de la manière la plus convenable pour la culture. » Autorisée par acte du Parlement en date de 1846, la Compagnie n'obtint que la concession des eaux du collecteur principal de Westminster, connu sous le nom de King's Scholars' Pond. Elle installa, en conséquence, à Fulham, sur la rive gauche du canal Kensington, une machine à vapeur qui élevait les eaux à 23 mètres. De ce niveau, les liquides étaient distribués par 25 kilomètres de tuyaux, dont les diamètres variaient entre 0^m,35 et 0^m,10. Les consommateurs avaient des robinets de prise, à des intervalles déterminés, et moyennant le paiement à la Compagnie d'une somme de 215 francs par an, ils avaient la libre jouissance des eaux.

Les jardins de Fulham ainsi desservis sont à peu près exclusivement affectés à la culture maraîchère. M. Lee, inspecteur-général du *Board of Health* a publié en 1831 les résultats de sa visite sur les lieux. Il avait constaté sur les légumes arrosés une croissance plus rapide, une végétation plus luxuriante et souvent une amélioration dans la qualité. Les choux, les concombres, les potirons, le céleri, les salades, se trouvaient très-bien de l'arrosage à la lance, mais à la condition, qu'il ne fût pas suivi de pluies. La différence entre les champs arrosés avec les eaux d'égout et ceux arrosés avec l'eau ordinaire, était très-sensible. Aucune émanation n'était perceptible à l'odorat et la nielle épargnait les récoltes arrosées.

L'avantage le plus notable, d'après M. Lee, résultait de l'application des eaux en temps sec.

Malgré ce rapport favorable, qui témoignait d'une amélioration d'un tiers dans le produit, la Compagnie se liquida. Un capital considérable avait été englouti dans la distribution et dans les dispositions prises pour l'écoulement direct des eaux d'orage. En outre, le district choisi regorgeait d'engrais excellents apportés en retour par les voitures des maraîchers; de sorte que les eaux des égouts, alors peu chargées de matières fertilisantes, ne pouvaient soutenir une aussi rude concurrence.

RUSHOLME.

En 1853, M. Worsley utilisait les eaux des égouts de la petite ville de Rusholme, près de Manchester, à l'arrosage d'une trentaine d'hectares. Une petite machine à haute pression, commandant deux pompes, élevait les eaux à 10 mètres dans un réservoir d'une contenance de 100 mètres cubes environ, d'où elles se distribuaient par 500 mètres de tuyaux en fonte de 0^m,075 de diamètre, et des tuyaux en bois, de 0^m,05 de même longueur. L'épandage à la lance des 70 mètres cubes dont on disposait journellement s'effectuait en 10 heures, sur moins d'un hectare. Les frais d'installation représentaient 416 fr. par hectare et les frais de distribution 121 fr. par hectare pour répandre par an, de 6 à 700 mètres cubes. Cette application n'était pas viable dans ces conditions; elle fut abandonnée quelques années plus tard.

WATFORD.

En 1854, lord Essex traitait avec la municipalité de Watford pour la jouissance des eaux d'égout, moyennant une redevance annuelle de 375 francs. La ville s'engageait, pour ce prix, à construire les bassins nécessaires et lord Essex, à installer la machine à vapeur, ainsi que les tuyaux de distribution, sur son domaine de Cashiobury.

La canalisation fut établie sur 85 hectares, mais le volume des eaux fournies par une population de 4000 âmes suffisait à

peine à l'arrosage de 20 hectares. En outre, la machine à vapeur, reconnue trop faible, dut être remplacée. Malgré une dépense inutile de 25,000 francs en tuyaux et en machine, lord Essex évaluait les frais de distribution de 270 m. cubes par jour à 0^m,12 en moyenne, et, en tenant compte de l'excédant de dépenses inutiles, à 0^m,07.

Les eaux, pour atteindre Cashiobury Park, ont à parcourir 400 mètres hors de la ville et débouchent dans des bassins où elles sont maintenues en agitation par une pompe à air qui les refoule, sans leur donner le temps de déposer. Les eaux d'orage sont détournées de ces bassins. Le conduit principal a 0^m,90 de diamètre; les tuyaux de distribution et les branchements en fonte, 0^m,06. Ces dimensions, trop petites, ne permettent de répandre que 300 m. cubes par jour au lieu de 450 m. cubes mis à la disposition du concessionnaire. Il n'y a, en outre, qu'une tubulure par hectare et demi.

Depuis 1858, les eaux sont distribuées régulièrement; 60,000 mètres cubes pour l'arrosage de 4 hectares de ray-grass; 40,000 mètres cubes pour 15 hectares de prairies et exceptionnellement pour quelques autres récoltes, telles que le blé, le trèfle, etc.

La dépense par hectare, en calculant sur une distribution de 60,000 mètres cubes à 0^m,10 pour 20 hectares, s'élèverait, d'après lord Essex, à 200 francs. Ce prix est moindre pour les prairies, mais triple pour le ray-grass.

Le volume d'eau nécessaire à chaque récolte est fixé de la manière suivante :

12 à 15,000 mètres cubes par hectare de ray-grass; pour obtenir 4 ou 5 coupes, il convient de ne pas suspendre l'arrosage pendant les mois d'été.

15,000 mètres cubes par hectare de prés; 350 à 400 mètres cubes par hectare de céréales.

Les égouts de Watford reçoivent les immondices et les déjections de la ville entière; la distribution d'eau potable représente environ 90 litres par habitant; de sorte que les eaux sont relativement riches.

Lord Essex a rendu compte dans les diverses enquêtes des

résultats agricoles obtenus chez lui. Suivant ses données, le ray-grass profite plus que toute autre récolte de l'arrosage. Sur 3 hectares de ray grass, 13 bœufs ont été engraisés pendant l'été, 8 chevaux et un grand nombre de porcs ont été nourris également en fourrage; tandis que dans les meilleures terres du Lincolnshire, on ne peut guère engraisser plus d'un bœuf par hectare. Les prairies artificielles offraient ainsi de grands avantages sur les prairies permanentes, à égalité de volume d'eau répandue. Il convient toutefois, pour les premières, de fumer après 3 ou 4 coupes avec un peu de superphosphate, afin de rétablir la balance; bien que les effets de l'arrosage après deux saisons consécutives soient perceptibles sur les deux ou trois récoltes suivantes.

L'application des eaux d'égout à la culture du blé n'a été faite à Cashibury qu'à titre d'essai. Un hectare et demi de blé fut arrosé à partir du mois de mars; la paille, aussi bien que la graine, avait augmenté et, déduction faite du prix des eaux, l'accroissement de produit par hectare fut évalué à 143 francs. Le temps avait été favorable; le sol argileux reposant sur du sable, n'avait pas été drainé.

Lord Essex cite aussi l'application avantageuse des eaux d'égout aux mangoldwurzel, aux choux et aux navets, que l'on peut transplanter à l'automne et aciver, de manière à obtenir au printemps une nourriture fraîche pour les agneaux, en augmentant d'un tiers le rendement par hectare.

ALNWICK.

La population d'Alnwick était en 1833 de 7,000 âmes environ. Grâce à une bonne distribution d'eaux potables, le débit journalier du collecteur principal était de 450 mètres cubes environ par 24 heures. Le duc de Northumberland, désireux d'appliquer ce volume d'eau à l'irrigation, chargea l'ingénieur Rawlinson, inspecteur du *Board of Health*, d'installer le système tubulaire sur ses propriétés. Comme le collecteur débouchait à peu près au niveau de la rivière Aln, M. Rawlinson fit construire à l'émissaire un réservoir d'une contenance de

80,000 litres correspondant au travail des pompes pendant deux heures. Ces pompes étaient commandées par une machine à vapeur de la force de 8 chevaux. Des tuyaux en fonte furent placés sur une surface de 108 hectares; les robinets de prise, à 180 mètres d'intervalle. Les dépenses faites en 1835 s'établissaient ainsi qu'il suit :

Frais préliminaires, nivellement	fr. 796,50
Pose des tuyaux, tranchées, etc.	» 4,940,00
Tuyaux en fonte, tubulures, etc.	» 15,400,00
Réservoir au collecteur.	» 768,00
Lignes volantes en gutta-percha.	» 1,500,00
Machine à vapeur de 8 chevaux	» 3,130,00
Pompes et transmission	» 4,155,00
Bâtiment de la machine	» 2,610,50

Total, fr. 27,000,00

L'arrosage ne commença à fonctionner régulièrement qu'au printemps de l'année 1835; mais l'année étant humide et froide les résultats furent médiocres. Dans les années suivantes, la dilution des eaux ne devait pas sensiblement améliorer les résultats; car la distribution d'eau potable, par suite des améliorations sanitaires du *Board of Health* avait été insensiblement accrue de 54 à 104 litres par habitant, et le débit des égouts calculé par M. Rawlinson à 450 mètres cubes par 24 heures, avait atteint, en 1856, 900 mètres cubes. Les pompes ne suffisaient plus. Aussi, en 1858, les eaux ne furent élevées que pendant 55 jours, et le duc de Northumberland fit installer de nouvelles pompes au prix de 2,250 francs. Les tableaux suivants indiquent le nombre de jours, à partir de 1858, pendant lesquels l'arrosage a pu être appliqué, la dépense moyenne de la distribution et l'état général des dépenses jusqu'en 1863.

ÉTAT DES JOURNÉES D'ARRROSAGE.				
	1850	1860	1861	MOYENNE
Journées de travail.	104	137 1/4	127 3/4	123
" de mauvais temps	96	90	115 3/4	100 (1)
" employées en réparation.	84	78 3/4	48 1/2	70 (2)
" de travail de la machine en dehors de l'irrigation	8	7	19	11 (3)
Dimanches et fêtes.	48	52	54	52

Frais de distribution.

	Moyenne des années 1859 à 1861
Entretien des pompes, chaudières et tuyaux	fr. 549,00
Gombustible.	" 796,95
Service de la machine	" 514 "
Service du réservoir et de la lance	" 453 "
Graissage et frais divers	" 48,65
Intérêt du fermier.	" 132 "

Total, fr. 2,493,80

(1) Pendant l'année 1859-1860, longues gelées et neige abondante; 1860-1861, année favorable; 1861-1862, très-humide.

(2) Cette perte de temps diminue chaque année.

(3) La machine servait à battre.

ÉTAT GÉNÉRAL DES DÉPENSES.			
	1859-60	1860-61	1861-62
Dépenses de distribution	1701,85	3002,50	2277,15
Id. par hectare	56,25	54,60	44,75
Dépenses totales	3251,85	4052,50	3327,15
Id. par hectare	78,10	73,80	65, "
Part des dépenses payées par le duc	2276,85	2732,00	2129,55
Id. par hectare	54,60	49,60	41,60
Part des dépenses payées par les fermiers	975, "	1329,60	1197,60
Id. par hectare	23,50	24,20	23,40

La dépense moyenne par hectare s'élevait ainsi, pour 123 jours de travail, à 54^{fr},22 par jour.

Quoique le Duc eût supporté pendant les trois années, 1859 à 1863, les deux tiers de la dépense totale, et qu'il abandonnât toute l'installation en parfait état, ses tenanciers n'ont pas consenti à continuer l'arrosage à leurs frais; les résultats, avec des liquides aussi dilués, n'offrant pas une compensation suffisante pour les frais d'élévation.

RUGBY.

La ville de Rugby avait été une des premières à suivre les recommandations du *Board of Health*. L'eau pure distribuée dans les maisons par des pompes à vapeur retourne par les évier et les water-closet aux égouts qui aboutissent à un réservoir où des pompes les reprennent pour les distribuer sur le sol. Le débit des égouts correspondant à une population de 8000 individus, est d'environ 1000 mètres cubes par jour. Les eaux d'orage sont détournées du réservoir, vers la rivière Avon. En 1853, M. Walker faisait poser près de 9 kilomètres de tuyaux sur 190 hectares de terrains arrosables, soit 47 mètres environ par hectare. Ces tuyaux avaient 0^m,15 et leurs branchements

0^m,07. Les robinets de prise au nombre de 66, représentaient une prise pour 3 hectares; à chaque robinet correspondaient 120 mètres de conduits en gutta-percha de 0^m,07 de diamètre, terminés par deux lignes volantes de 100 mètres de longueur.

Cette installation coûta 75000 francs, soit environ 395 fr. par hectare, et M. Walker évaluait la dépense, y compris l'intérêt de cette somme, à 12500 fr. par an, dont la moitié, soit 6250 francs, pour la distribution seulement.

En ajoutant 1250 francs, prix de la concession payée à la ville, les frais atteignaient le chiffre de 70 francs par hectare.

Or, 1000 mètres cubes d'eau fournis par une population de 8000 âmes représentent sur 190 hectares, le produit de 40 individus par hectare et par an. En outre, 1000 mètres cubes par jour ne peuvent servir à arroser que 4 hectares, soit 250 mètres cubes par hectare. Il en résulte que pour irriguer 190 hectares, on devait consacrer 47 jours, c'est-à-dire attendre 47 jours pour répéter l'arrosage sur un hectare, et cela, pour y répandre un volume d'eau correspondant à peine à 0^m,02 de pluie.

Il n'y a donc pas lieu de s'étonner si M. Walker abandonnait en 1860, le système tubulaire pour l'irrigation par rigoles de déversement.

ÉDIMBOURG.

A la ferme de Loch End, située au N.-O. d'Édimbourg, on trouve une application de l'arrosage à la lance sur une surface de 5 hectares de terres arables. Une dérivation des eaux de l'égout Foul Burn, fait mouvoir une roue hydraulique de 4 mètres de diamètre qui commande quatre pompes et élève environ 600 litres par minute. Le sol très-meuble ne pouvant se prêter à l'irrigation par rigoles ouvertes, on a fait établir un conduit unique dans le sens de la pente, et à l'aide de robinets de prise placés à 50 mètres de distance, on arrose avec des lignes volantes en gutta-percha, moyennant une dépense annuelle, pour 20,000 mètres cubes d'eau, d'environ 250 francs par hectare.

On récolte en juillet des pommes de terre hâtives, et l'on sème du raygrass que l'on défonce tous les deux ans. Le revenu

par hectare est évalué à 2,000 francs; chaque coupe de raygrass représente de 600 à 700 francs par hectare, et M. Scott fait de trois à quatre coupes par an et trois arrosages par coupe.

VI. — IRRIGATION PAR RIGILES DE NIVEAU ET DE DÉVERSEMENT.

Dans le système tubulaire, nous venons de le montrer, les dépenses d'installation et d'entretien sont en général hors de proportion avec les résultats obtenus; le volume d'eau que l'on peut répandre en un temps donné est insuffisant pour le débit des égouts d'une ville bien drainée. Comparé au système d'irrigation par rigoles de niveau et de déversement, il entraîne le plus souvent l'emploi de moteurs dispendieux, l'établissement de réservoirs à différents niveaux, et une main-d'œuvre considérable pour la manœuvre des lignes volantes; outre des réparations coûteuses dues à l'excès de pression dans les tuyaux; enfin, il est essentiellement irrégulier. Sauf deux ou trois localités où ce système d'arrosage a été installé dans des conditions d'une scrupuleuse économie, pour des liquides plus riches que ceux des égouts, et n'exigeant pas l'épandage de toutes les heures du jour et de la nuit, les autres l'ont forcément abandonné.

Examinons actuellement les villes où l'on utilise et l'on désinfecte les eaux sales par simple irrigation.

MILAN.

Les irrigations du Milanais sont les plus anciennes de l'Italie; leur origine remonte à l'époque ancienne décrite par Diodore de Sicile et chantée par Virgile. Elles ont, au treizième siècle, donné lieu à des luttes acharnées, lors de l'affranchissement des communes Lombardes. L'art des irrigations, d'après les contemporains, était alors arrivé à un haut degré de perfection (1). Toutefois, ce n'est que vers le milieu du quinzième

(1) G. Heuzé. *L'agriculture de l'Italie septentrionale*. Paris 1864.

sibele que la culture de la contrée se ressentit des effets de l'étude du régime des eaux et de la science des arrosages. Depuis cette époque, il devient une source féconde de prospérité nationale. L'examen de cette question, intéressante à tant de titres, est en dehors du cadre de ce travail. Nous avons seulement à choisir ici parmi la multitude de canaux qui sillonnent les plaines de l'Italie septentrionale, ceux qui entraînent directement les déjections de la ville de Milan.

Le drainage de cette ville qui renferme 130,000 habitants, a été souvent décrit. Les égouts et les drains particuliers des maisons de la ville centrale se rendent, sans exception, dans un canal intérieur et couvert, la *Sevese*, qui reçoit les eaux courantes et celles des faubourgs que lui apporte, par trois aqueducs, un second canal concentrique au premier, et à ciel ouvert, le *Naviglio*. L'ensemble de ces liquides est finalement recueilli par un troisième canal, à ciel ouvert, la *Vettabbia*, qui débouche au sud de la ville et va fertiliser une vaste surface de prairies, sur un parcours de 16 kilomètres, avant de se jeter dans la rivière Lambro.

Les eaux de la Vettabbia ont sur celles des autres canaux de la Lombardie et du Piémont qui dérivent des monts Alpins, l'avantage d'offrir une température toujours plus élevée. Leur température est souvent même supérieure à celle de l'air ambiant; parce qu'elles circulent souterrainement sur une grande partie de leur parcours. Elles tiennent, en outre, en dissolution et en suspension une telle quantité de matières solides qu'au bout de quelques années, on est obligé d'enlever, sur plusieurs centimètres, la croûte provenant du colmatage, afin de maintenir au niveau déterminé la surface des prairies arrosées. Le limon ainsi écrouté se vend aux maraîchers au même prix que le fumier et assure, pour chaque opération, un bénéfice de 5 à 600 francs par hectare. Au contraire, avec les eaux pures et limpides des autres canaux, il faut tous les deux ou trois ans, fumer les prairies; il a été reconnu que l'action de l'eau ne permet de doubler et de tripler le revenu de la terre qu'à la condition d'y mettre de l'engrais. Ainsi, point d'engrais avec les eaux limoneuses de la Vettabbia. En

outre, grâce à leur tiédeur, les prairies permanentes sont arrosées tout l'hiver et la végétation s'y continue artificiellement, lorsque la neige ou la glace couvrent les terres arables environnantes. C'est la raison du nom de *marcites* ou prairies d'hiver, donné à ces prés.

Les marcites se distinguent des prairies ordinaires dont la surface en pente douce est alimentée par un canal supérieur distribuant l'eau dans des saignées suivant les lignes de niveau, en ce qu'elles sont sillonnées transversalement et divisées en compartiments ou *ailes* de 0^m,03 de pente et de 7 mètres environ de largeur. C'est entre ces ailes, et au sommet des ados de distribution que sont les rigoles de distribution.

Ces rigoles ont 0^m,30 de largeur sur 0^m,25 de profondeur. L'eau vient sur chaque arête supérieure, ruisselle sur le gazon et tombe dans des colatures ou rigoles de 0^m,20 à 0^m,25 de largeur sur 0^m,16 à 0^m,20 de profondeur, qui l'entraînent par une pente de 3 à 5 pour 100 dans le fossé d'écoulement ou colateur. Une planche de 120 mètres de longueur ainsi répartie en compartiments, est suivie d'une autre un peu plus courte, où le colateur de la première, devient irrigateur dans la seconde. La reprise des mêmes eaux s'opère ainsi trois fois et même jusqu'à douze fois, sur la même prairie. Cette reprise paraît indispensable, car en évaluant le produit minimum de la Vettabbia à 100,000 mètres cubes par 24 heures, ou 1 mètre cube à la seconde, et la tranche liquide nécessaire à la consommation d'un hectare de marcites par 24 heures, à 0^m,30 de hauteur, on trouve que les eaux de ce canal ne pourraient fertiliser que 30 hectares au lieu d'un millier actuellement irrigués.

L'eau, toujours ruisselante à la surface, abrite le gazon du froid et des vents; de sorte qu'il s'épaissit de décembre à février et devient assez abondant pour permettre une première coupe en février. On suspend l'arrosage huit jours au moins avant de faucher. Les produits de l'année sont proportionnels à la dépense d'eau. L'herbe, mélangée de ray-grass et de trèfle, se coupe six fois; le produit se décompose, par hectare, de la manière suivante :

1 ^{re} coupe février,	12,000 kil.
2 ^e » avril	12,000 »
3 ^e » juin	9,000 »
4 ^e » août	9,000 »
5 ^e » octobre	6,000 »
6 ^e » décembre	6,000 »
	54,000 »

Cette production verte qui s'élève parfois jusqu'à 80 tonnes par hectare, représente environ 13,000 kil. de foin. Les coupes de l'hiver sont de moins bonne qualité que celles de la fin du printemps et de l'été, que l'on convertit en foin. Les coupes de l'arrière-saison sont données en vert à l'étable.

Une bonne marcite donne un produit net de 500 francs par hectare et par an; on estime que l'hectare suffit à l'entretien de trois vaches laitières à l'année. La valeur vénale atteint quelquefois jusqu'à 15,000 francs l'hectare.

D'après les tarifs en usage, l'eau de la Vettabbia se paye un prix double de l'eau des autres canaux; c'est-à-dire, de 700 à 800 francs l'once ou module magistral qui débite 44 litres par seconde. En d'autres termes, 100 mètres cubes par jour sont payés 50 fr. par les locataires à l'année, tandis que 100 mètres cubes d'eau des autres canaux se payent 25 francs seulement.

Les marcites commencent sous les murs mêmes de Milan, et aucune atteinte, depuis six siècles d'existence, n'a été portée par leur voisinage, à la santé publique. L'eau constamment courante est absorbée par un sol perméable et rejetée sans qu'il y ait stagnation. D'ailleurs, la commission anglaise chargée de l'enquête sur la salubrité des marcites, en 1857, n'a pu constater aucun fait indiquant, dans les localités arrosées, une prédisposition aux épidémies, ni aux fièvres endémiques.

EDIMBOURG.

La ville d'Édimbourg offre un exemple moins ancien, mais non moins remarquable, de l'application des eaux d'égout. Ces eaux sont, en effet, utilisées depuis près de deux siècles

sur une partie des prairies de Craigintenny, et depuis plus de 60 ans sur une centaine d'hectares.

Le ruisseau Foul Burn, qui dessert ces prairies, reçoit les produits d'une moitié de la population d'Édimbourg, soit environ 100,000 individus. Cette moitié, qui correspond à la vieille ville, ne jouit pas d'une distribution d'eau potable abondante; les water-closet y sont rares, le système des fosses d'aisance y a prévalu jusqu'ici. On remarquera, toutefois, d'après les analyses (tableau, page 8), que ces eaux ont une richesse fertilisante égale, sinon supérieure, à celle des eaux de Londres, de Croydon, etc. Au sortir de la ville, le Foul Burn est à ciel ouvert; une dérivation à Sunny Bank, à l'est de la route de Berwick, alimente des prairies depuis le siècle dernier; puis il atteint Lochend Farm, au N.-O., où 5 hectares sont arrosés à la lance après l'élévation des eaux (1) et 10 hectares par rigoles de niveau.

Loch End. — D'après M. Taylor, chaque hectare de pré de la ferme *Loch End* reçoit environ 80,000 mètres cubes d'eau par an. L'arrosage commence en mars et finit en novembre. Le sol est sablo-argileux et le sous-sol formé de trap. Les plantes dominantes des prairies sont le *poa trivialis* (paturin) et le *triticum repens* (chiendent) moins précoce que le précédent. La totalité du fourrage est donnée en vert aux vaches. Sans avoir tenu note de la production, M. Scott, propriétaire de *Loch End farm*, estime que le revenu annuel de la terre a augmenté de fr. 325 à fr. 1500 par hectare. M. Scott recueille, en outre, dans un réservoir où les eaux d'égout séjournent quelques temps un dépôt de matières noires animalisées qu'il vend aux maraîchers, à l'état de terreau, au prix de 3 à 6 fr. le mètre cube. Mais cette pratique a de grands inconvénients au point de vue sanitaire.

De *Loch End farm*, le Foul Burn se dirige vers Craigintenny, dont les prairies, à trois kilomètres de la ville, s'étendent entre la mer et la route de Leith à Portobello.

(1) Voir page 76.

Craigintenny. — Les prairies de ce nom appartiennent à M. Miller; elles comprennent 77 hectares. La nature du sol est très-variable: dans la partie désignée sous le nom de *Figgate-Whins*, qui longe la mer, il se compose de sable absolument pur, sans aucune valeur avant l'arrosage; dans la partie ouest, il est formé d'argile de bonne qualité.

Vers l'année 1800, 50 hectares de prés étaient arrosés par le Foul Burn; en 1821, on ajouta 12 hectares de terres pauvres et 5 hectares de sable. Les 12 hectares s'affirmaient ensemble au prix de 1000 francs par an.

En 1834, sur les 77 hectares arrosés à Craigintenny, 50 appartenaient à M. Miller et le reste au comte d'Haddington, de Moray, etc. Les prairies irrégulièrement tracées et assez mal cultivées, donnaient alors de 4 à 6 coupes par an, pour l'alimentation des vaches. Le fourrage était vendu chaque année aux enchères par petites parcelles correspondant à 0^{hect}, 10 et rapportait annuellement de 1500 à 1850 francs l'hectare. Du reste, dans certaines années de disette de fourrage, comme en 1826, l'hectare rapporta jusqu'à 3,500 francs au comte Moray. M. Miller établit, en 1827, que 45 hectares de prairie lui avaient rapporté net de tous frais 50,250 fr.; ces frais par an et par hectare atteignaient 50 fr. environ (1).

Le Docteur Stark, d'Edimbourg, décrit ainsi le procédé suivi à Craigintenny (2):

Le sol nivelé et parfaitement drainé, on le divise par des tranchées ou rigoles assez profondes, en compartiments de 0^{hect}, 20. On commence à arroser un des compartiments dans la première semaine de novembre, puis au bout de deux ou trois jours, un compartiment nouveau; de façon à ce qu'il y ait toujours un compartiment sous l'eau et l'autre en drainage. La totalité des eaux est ainsi déversée sans interruption. Les fermiers qui ont beaucoup d'eau et peu de surface, laissent un intervalle d'une quinzaine avant de discontinuer l'arrosage sur un même compartiment; dans le cas inverse, on n'arrose chaque

(1) Ces détails sont empruntés à *Practical Irrigator*, par M. Stephen.
(2) *Farmers Magazine*, t. XXXI, p. 285.

compartiment qu'une fois par quinzaine et successivement, de manière à ne revenir sur le premier compartiment qu'à l'expiration de la quinzaine.

Les eaux d'orage, chargées de limon, sauf dans la saison d'hiver où il n'y a pas de végétation active, sont rejetées directement à la mer, car l'expérience a fait reconnaître leurs inconvénients pour la culture.

Les meilleurs prés donnent de 4 à 5 coupes par an; les autres, de 3 à 4. Si on laisse trop d'intervalle entre les coupes, la récolte pourrit sur pied, ou son poids la fait verser et chauffer.

En 1846, 73 hectares étaient répartis en 240 compartiments, et quinze compartiments étaient arrosés par jour jusqu'à ce que la totalité eût reçu l'arrosage. On suspendait pendant trois jours seulement, avant la coupe. En 1845 et 1846, la pièce n° 1 (Craigintenny), d'après les livres de MM. Stewart, agents de M. Miller, avait été arrosée aux dates suivantes:

1845.	1846.
le 3 mai.	le 30 janvier.
14 id.	18 février.
3 juin.	5 mars.
20 id.	22 id.
7 juillet.	2 avril.
24 id.	13 id.
15 août.	10 mai.
31 id.	28 id.
8 octobre.	14 juin.
21 id.	30 id.
24 novembre.	5 août.
31 décembre.	19 id.
	17 septembre.
	12 octobre.
	4 novembre.

Pendant l'année 1845, l'arrosage n'ayant eu lieu que de jour, on ne fit que trois coupes; en 1846, on arrosa nuit et jour et on obtint quatre coupes, dont la première à la fin de mars. En hiver, on n'arrose que le jour et on suspend en temps de

gelée. Deux hommes suffisent pour le service des 75 hectares; le curage et la réparation des rigoles sont confiés à un troisième ouvrier.

On calcule actuellement sur l'arrosage de 25 hectares par semaine, soit une distribution par hectare toutes les trois semaines, et l'on fait de 4 à 5 coupes annuellement. L'herbage sur pied, est évalué par hectare et par an à 200 tonnes, rendement moyen; son prix, variable suivant la saison, etc., etc., de 1^{re} 20 à 2^{es} 80 les 100 kil. Il se compose principalement de *poa trivialis* (paturin commun), qui passe pour la graminée la plus précieuse dans les prairies, de *triticum repens* (chiendent) de bonne qualité aussi, mais d'une croissance plus rapide et de *ray-grass* ordinaire. On loue aux enchères les coupes des prairies; celles des sables à 4,250 et 4,750 fr. l'hectare; celles des prairies hautes à 2,500 fr. L'acquéreur, moyennant cette somme annuelle, fait quatre ou cinq coupes, à son choix, du 1^{er} avril au 10 octobre. Passé cette date, le propriétaire fait paître jusqu'à l'hiver.

Il est difficile d'obtenir un renseignement exact sur le volume d'eau consommé à Craignintenny. On admet que le débit moyen du Foul Burn étant de 6200 litres par minute, les prairies reçoivent en moyenne, pendant neuf mois, une couche d'eau totale de 1^{re} 80 à 2^{es} 10.

Le sol a une pente de 1 pour 100 environ; le drainage en a été récemment complété.

Sur 25 hectares seulement, les eaux du Foul Burn sont élevées par une machine à vapeur de 8 chevaux à la hauteur de 6 mètres, et à ce niveau elles sont distribuées par des rigoles ouvertes. L'arrosage dure d'avril en octobre et on y fait rarement plus de trois coupes par an.

On a objecté à l'irrigation telle qu'elle est pratiquée à Craignintenny, que les eaux y sont trop rapidement enlevées par les drains, avec perte des principes fertilisants, et que, si le volume des eaux consommé était moindre, la surface irriguée pourrait être plus considérable. L'opinion des propriétaires est que, grâce au drainage perfectionné, les liquides pénétrèrent utilement à une plus grande profondeur et qu'un plus long

séjour des eaux diminuerait la qualité de l'herbage; il suffit, pendant l'été, de boucher quelques-uns des drains afin de maintenir un peu plus d'humidité dans le sol. On a souvent répété que l'irrigation à Craignintenny donnait lieu à des émanations nauséabondes, même à une certaine distance. Dans nos visites, nous n'avons constaté aucune odeur du fait de l'arrosage; car, les gaz sont complètement absorbés après cinq ou six minutes (1). Les seules plaintes dont nous ayons eu connaissance, sont motivées par la circulation des liquides dans les ruisseaux à ciel ouvert où les dépôts sont trop rarement enlevés. Il serait facile de remédier à cet inconvénient en canalisant les eaux dans un égout voûté depuis les portes de la ville jusqu'aux prés, ou tout au moins en curant plus fréquemment les rigoles.

Roseburn et Dalry. — A l'ouest d'Edimbourg, les prairies les plus étendues, après celles de Craignintenny, sont celles de Roseburn et Dalry, réduites par les exigences du chemin de fer du littoral de 40 à 32 hectares. L'égout, dont les eaux sont ici utilisées depuis quarante ans, reçoit toutes les issues et déjections d'un vaste abattoir et de plusieurs distilleries. Le sol est sablo-argileux; le sous-sol argileux. L'arrosage continue nuit et jour, sans en excepter le dimanche. Les eaux, en été, ne séjournent que quelques heures; en hiver, leur action est prolongée dans le but non plus d'arroser seulement, mais de fumer la terre par colmatage. Des quinze ou vingt espèces de graminées semées à l'origine par le propriétaire, M. Thomson, trois ou quatre seulement ont survécu et se sont propagées au détriment des autres.

Grange. — Les prés Grange, comprenant de 6 à 7 hectares, sont situés au sud de la ville. Les eaux sont riches, et M. Mac Gill, le propriétaire, assure que plus le volume consommé par hectare est considérable, meilleurs sont les produits. On

(1) C'est à tort que M. le Préfet de la Seine affirme que l'irrigation se faisant par immersion à Edimbourg, « les odeurs qui se répandent aux alentours sont parfois insupportables », p. 48. *Première introduction aux Eaux de Paris*, 1854.

arrose pendant tout l'hiver; dans l'année, on chôme six semaines correspondant aux fauchages. Les terres sont compactes, d'une pente très-forte. On fait de quatre à cinq coupes, qui se sont vendues, en 1862 par exemple, au prix de 800 à 2500 fr. par hectare; cet écart est dû au volume d'eau répandu, à la nature du sol, à la qualité de l'herbage et aux facilités de transport plus ou moins grandes pour les nourrisseurs.

Rosebank. — Les prés Rosebank couvrent une surface de deux hectares et demi, ils sont arrosés depuis trente ans. L'arrosage qui a lieu pendant onze mois de l'année cause une dépense de fr. 2,50 par jour, pour payer un homme qui opère le mouvement des eaux à ses heures de repas et après le travail de la journée à l'atelier. Le curage des canaux se fait l'hiver par des ouvriers supplémentaires. Les boues des rigoles se vendent au prix de 3 fr. la tonne. Le volume d'eaux disponible est énorme, mais M. Reid n'en consomme qu'une faible partie, car il n'a que deux hectares à un niveau convenable et il ne croit pas qu'il y aurait intérêt à élever les eaux. Sur ces deux hectares, l'eau coule pendant trois ou quatre jours consécutifs par parcelle de 0^{hect},10 à 0^{hect},20, et à deux reprises avant de faucher. On n'arrose que lorsque l'herbe a repris sa pousse. Le prix des coupes annuelles est de 1500 à 1800 francs par hectare. L'eau, vu la petite surface irriguée, ne sort pas limpide.

En été, M. Reid arrose de temps en temps 0^{hect},80 de jardins potagers; les eaux d'égout conviennent surtout aux choux, aux oignons et aux turneps.

Quarry holes. — Les prairies de Quarry holes, qui comprennent 3 hectares, sont affermées par M. Skirving. Le volume d'eau disponible annuellement est de 160,000 mètres cubes. Les eaux coulent nuit et jour pendant toute l'année, sauf quand il gèle fort. Chaque compartiment de 0^{hect},40 reçoit l'eau pendant deux jours consécutifs et trois arrosages dans l'intervalle de chaque coupe. On attend deux ou trois jours avant de reprendre, et on cesse quand l'herbe est trop haute.

Le tableau suivant résume les conditions de l'irrigation à Edimbourg, en 1864.

	NOMBRE D'HECTARES ARROSÉS.	POPULATION CORRESPONDANT À 1 HECTARE	VOLUME D'EAU DISPONIBLE PAR HECTARE ET PAR AN.
Loch End et Craigintenny .	115,3	842 habit.	51,250 m. ³
Roseburn et Dalry	32,3	280 -	42,500 -
Quarry Holes	3,2	1405 -	162,500 -
Broughton Burn	2,4	4165 -	255,000 -
Grange	6,6	755 -	240,000 -

Bien que les chiffres de la troisième colonne représentent le volume d'eau disponible et non la consommation, on remarquera que les exemples fournis par les prés d'Edimbourg ne sont pas recommandables sous le rapport de l'économie des liquides. D'ailleurs, la ville qui n'a pas fait de travaux, ne perçoit rien pour cette matière fertilisante. Aussi, le produit par hectare est-il plus élevé sur ces prairies que partout ailleurs.

TAVISTOCK.

La ville de Tavistock avait été drainée en 1850, conformément aux principes du *Board of Health*. Le duc de Bedford fit disposer 38 hectares de prés (dont 6 hectares seulement étaient drainés) de manière à y dériver les eaux des égouts. Le collecteur amène les eaux de la population de 6,000 individus répartis sur 80 hectares, à 1 kilomètre hors la ville, dans un canal de 1^m,60 de profondeur, d'où les eaux se déversent à gueule-bée sur les prairies.

Un autre canal de 0^m,30 à 0^m,90 de largeur, avec saignées, sert à l'irrigation par ados d'une partie des prés, affermés à deux personnes différentes.

L'arrosage a lieu toute l'année, depuis 1851, et les eaux ne sont écoulées directement à la rivière que lorsque l'herbe est trop haute.

D'après M. Austin, la dépense d'installation s'est élevée à 800 francs par hectare.

BIRMINGHAM.

Depuis une dizaine d'années, M. Burbridge consomme pendant quelques mois seulement les eaux non filtrées des égouts de Birmingham. L'arrosage se fait à la fin de février sur 20 à 25 hectares de prairies; le volume répandu par mois est, pour toute la surface, de 54,000 mètres cubes environ.

La ville a depuis longtemps approuvé un projet d'utilisation des eaux, fondé sur la différence de niveau entre l'émissaire et les eaux de la Tame; mais la municipalité n'a pas les pouvoirs nécessaires pour pousser la canalisation en dehors de la ville.

MALVERN.

M. Mac Cann exploite à Malvern et à Mathon, dans le comté de Worcester, une ferme de 200 hectares. Les eaux de la ville de Malvern (7000 habitants) lui servent à arroser une vingtaine d'hectares. Sauf entre 9 heures et 11 heures du matin, ces eaux sont peu chargées. Le sol est de composition variable, argileux ou sableux, mais le plus souvent compacte et accidenté. La pente vers la Severn est très-rapide. L'arrosage a lieu par parcelles de 0^m et 10. Les 20 hectares sont en ray-grass que l'on coupe deux fois et que l'on fait pâturer ensuite. La première coupe donne 6000 kil. par hectare; la seconde 3000 kil.

Les frais d'installation ont été de 180 fr. par hectare; les frais de distribution pendant 8 mois, de 28 francs.

M. Mac Cann ne paie rien à la ville pour la jouissance des eaux; mais il s'engage à désinfecter par l'arrosage celles qu'il consomme. L'emploi des eaux correspond à un rendement de 2 tonnes de foin en plus par hectare, ou de 500 pour 100 en fourrage vert. Des essais d'arrosage sur l'orge, les turneps, les mangold ont été très-satisfaisants.

Sur d'autres fermes de ce district, à Link's farm, par exemple, 12 hectares de prairies sont arrosés et depuis l'irrigation, le prix du fermage a plus que doublé.

CARLISLE.

La ville de Carlisle compte 30,000 habitants; les égouts tubulaires établis sous le bénéfice de la loi de salubrité de 1848, y reçoivent les déjections de 22,000 habitants et aboutissent, en dehors de la ville, à un puits, où une machine à vapeur de 5 chevaux les élève de 3^m à 3^m,60, après qu'elles ont été désinfectées par le fluide Mac Dougall (voir page 29). Un canal à ciel ouvert fait le tour du terrain soumis à l'irrigation, en suivant la rivière Caldew sur une partie de son parcours. Des saignées pratiquées sur ce canal permettent aux eaux de s'écouler dans des rigoles mobiles, en forme d'auge, en fonte, qui s'ajustent bout à bout. Ces rigoles sont destinées à remplacer celles que l'on creusait autrefois dans le sol et que le bétail dégradait.

La ferme exploitée par M. Mac Dougall appartient au duc de Devonshire et comprend 42 hectares qui s'étendent au pied du vieux château; mais 28 hectares seulement, bornés par les rivières Caldew et Eden et le chemin de fer Calédonien, sont irrigués. Le sol est sableux et très-perméable. La totalité des 28 hectares est en prairie permanente, on n'y fait pas de foin; le tout est pâturé, et il est assez difficile de déterminer exactement le bénéfice net de l'irrigation. Le volume d'eau consommé est évalué à 5000 mètres cubes par jour; ce qui représenterait par hectare et par an de 30 à 22000 mètres cubes; l'arrosage se renouvelle quatre fois dans l'année, sur la même surface.

Les 42 hectares, dont 28 arrosés, nourrissent en moyenne 600 moutons et 90 ou 120 bêtes à cornes. Le prix payé par tête de gros bétail est de 4,35 à 5 fr. et par mouton, de 0,60. Mais on arrive à une appréciation plus convenable du produit en se basant sur le fait que M. Mac Dougall a affermé les 42 hectares, au prix de fr. 20000 et qu'il touche en sus un bénéfice de fr. 12000.

Les herbages de Carlisle sont de très-bonne qualité; peut-être même est-elle supérieure à celle des prés d'Edimbourg; ce qui s'explique naturellement par le parcage du bétail. Mais M. Mac Dougall veut voir dans cette supériorité une preuve de l'efficacité du phénate de chaux qui conserve l'ammoniaque dans les eaux

jusqu'à leur absorption dans le sol et qui détruit les plantes parasites. Quoi qu'il en soit, la désinfection paraît à peine nécessaire à Carlisle; dans notre visite, pendant l'été de 1864, les eaux n'avaient aucune odeur nauséabonde avant l'introduction de l'acide phénique; les matières solides y étaient à peine désagrégées et, de fait, la décomposition n'avait pas eu le temps de se faire avant l'épandage. Il convient toutefois, d'ajouter que la dépense de la désinfection représente à peine 0,10 par an et par habitant et que l'herbe est pâturée non-seulement sans répugnance, mais encore, d'après M. Mac Dougall avec une préférence très-marquée par le bétail.

CROYDON.

La population à Croydon atteint le chiffre de 18,600 habitants; la quantité d'eau potable par habitant est de 180 litres par jour ou de 65 mètres cubes par an. Le volume des eaux de la surface y est d'environ 272 litres par jour et par habitant ou de 98 mètres cubes par an.

Les habitations sont pour la plupart en communication directe avec les égouts, et le drainage établi par le procédé économique des égouts tubulaires, conformément à la loi de 1848, se fait si rapidement qu'en 1857, lorsque l'on arrosait seulement 6 hectares avec les deux tiers du volume des eaux de la ville, le sol était si complètement recouvert de matières stercorales qu'on ne pouvait en approcher. Depuis lors, les eaux, amenées à ciel ouvert jusqu'aux réservoirs, y sont filtrées (voir page 30) avant d'être écoulées dans les rigoles d'irrigation. De ces rigoles, qui ont 0,30 de largeur sur 0,30 de profondeur, partent à des intervalles de 12 à 15 mètres, d'autres rigoles plus petites dont on fait déborder les eaux en les interceptant sur un point de leur parcours, par des vannes mobiles.

L'eau, se déversant à gueule-bée sur un premier compartiment, est reçue dans une seconde rigole qui la dérive de nouveau sur un second compartiment, et finalement elle retourne à la rivière par un canal d'issue. Les terres des niveaux supérieurs sont ainsi directement arrosées; tandis que celles des

niveaux inférieurs le sont après que les eaux ont filtré une fois à travers le sol.

On compte, en été, sur une perte par absorption et par évaporation d'environ moitié des liquides, et, en hiver, sur une perte d'un tiers.

L'eau du canal d'issue est incolore et insipide; son odeur est encore nulle après quatre heures de repos. Aussi, ne peut-on la distinguer au goût de celle de la rivière Wandle, dont elle constitue le cinquième environ en volume.

Les prairies, situées à 1 kilomètre et demi de la ville, sont contiguës à la propriété de Beddington Park. Une pente douce favorise l'écoulement vers la Wandle. A l'exception de 8 hectares qui sont de niveau, la pente est de 4 millimètres par mètre. Le sol est argilo-sableux, l'épaisseur de la couche arable varie entre 0,08 et 0,60; au-dessous se trouve une couche de 1,50 à 1,80 de gravier, puis une nouvelle couche de 0,60 d'argile peu tenace; enfin, du gravier qui repose sur la craie.

Cédant aux injonctions des tribunaux, la municipalité de Croydon applique les eaux à l'arrosage depuis 1859. En 1860, 22 hectares furent affermés, partie en blé et en avoine, partie en trèfle et en ray-grass, partie enfin en prairies. Comme le blé et l'avoine ne permettent pas un arrosage régulier, on força la dose sur le reste de la surface. Les résultats n'en ont pas moins été très-remarquables. Ainsi, on vendit deux coupes d'herbe sur pied; la première, en juin, au prix de 250 fr. par hectare; la seconde, en août, au prix de 94 fr. La première récolte de trèfle fut cédée au prix de 280 fr. l'hectare; la seconde au prix de 200 fr. Enfin, la coupe de ray-grass valait 190 fr., en juin, et 175 fr. par hectare, en août. L'avoine, qui n'avait pas été arrosée superficiellement, avait profité de l'eau écoulée par les drains dans le sous-sol; aussi, les 4 hectares en avoine, qui n'avaient produit jusque-là que 125 à 150 kil. à l'hectare, rendirent 380 kil., malgré la sécheresse de l'année.

En 1861, l'administration municipale affermit, à son tour, à M. Marriage, pour huit années, 120 hectares au prix de 315 fr. l'hectare, au lieu de 250 fr. qu'elle payait elle-même. Elle s'engageait, pour cette redevance, à couvrir jusqu'à concurrence de

200 fr. par hectare, les dépenses d'installation nécessaires à l'arrosage; le fermier devant seulement pourvoir aux frais d'entretien. Le coût de l'installation a varié, au total, entre 350 et 600 fr. par hectare. La dépense du filtrage est à peu près couverte par la vente de l'engrais.

En 1862, on arrosait 98 hectares et en 1864, plus de 100 hectares par parcelles de 8 à 12 hectares à la fois. La plus grande partie de la surface est en ray-grass; on arrose chaque compartiment pendant quatre jours et quatre nuits consécutivement et trois fois entre chaque coupe.

Du reste, on se règle sur la saison pour prolonger ou diminuer la durée de l'irrigation. En temps humide, on peut arroser de plus grandes surfaces. En temps sec, on dispose d'un volume d'eau insuffisant pour maintenir humide toute la surface en ray-grass. On a reconnu, en effet, que 5 hectares suffisaient, en été, pour absorber pendant 24 heures les 3600 mètres cubes fournis par le collecteur, sans que l'eau reparût à la surface; le lendemain seulement, elle se drainait par la rigole inférieure.

Un homme fait le service de l'arrosage, et opère le curage des rigoles, sur une étendue de 15 à 20 hectares.

On fait actuellement 4 coupes de ray-grass par an, soit de 75 à 90 tonnes de fourrage vert par hectare; on fauche en avril pour la première fois, et en octobre ou en novembre, la dernière fois. Le produit se vend en vert au prix de fr. 31,25; et sur pied, au prix de 20 fr. Ces prairies permanentes donnent aussi 4 récoltes à l'année, mais l'herbage en est moins estimé par les nourrisseurs; le produit par hectare et par an varie de 100 à 150 fr.

M. Marriage a appliqué aussi l'arrosage aux mangold-wurzel.

En ne tenant pas compte des conditions du fermage, M. Marriage estime que le produit brut dû à l'arrosage, est pour le ray-grass, de 0',075 à 0',10 par mètre cube d'eau d'égout et de 0',05 à 0',07 pour les prairies. Il est certain que ces chiffres s'abaisseraient notablement, s'il y avait abondance de fourrage vert sur le marché.

RUGBY.

Nous avons déjà décrit (page 75) l'installation du système tubulaire à Rugby. En 1860, M. Walker renonçait à ce système

et appliquait les eaux par déversement sur 160 hectares, mais le volume consommé par hectare (1500 à 2500 m. cubes) est insuffisant; aussi, n'arrose-t-on que cinq ou six jours par an chacun des hectares. Comme les prairies sont en pâture et qu'on ne fait qu'une seule coupe, il est difficile d'évaluer le produit. M. Walker établit pourtant que le prix de l'hectare a doublé; ce qu'il payait 110 fr., vaut actuellement 220 fr.

Quoi qu'il en soit, cette application, tant à cause des dépenses d'épuisement, de canalisation, du loyer des eaux, que par suite des différences de niveau et du mode de culture, ne saurait servir d'exemple. Mais Rugby a été le champ des expériences suivies depuis 1861, par M. Lawes pour compte de la Commission parlementaire, et à ce titre Rugby mérite de nous arrêter plus longuement.

Expériences de M. Lawes.

Les essais de M. Lawes ont été entrepris à la demande de la Commission du Sewage, sur 6 hectares de prairies appartenant à M. Walker et affermés à M. Campbell. Ces six hectares parfaitement drainés comprennent deux lots, dont un de 2 hectares et l'autre de 4 hectares, dressés d'après le système Bickford (1). Ce système consiste, comme celui de Siegen (méthode allemande), à faire contourner tous les accidents du terrain par les rigoles, de manière à assurer à la fois l'arrosage et l'égouttement sans travaux de nivellement. A l'entrée de chaque rigole de falte, un réservoir de 3 tonnes et demie permettait de mesurer exactement le volume d'eau débité et de puiser des échantillons pour les analyser. Le lot de 4 hectares avait été partagé en deux compartiments de deux hectares chacun et chaque compartiment en quatre planches, à savoir : n° 1, non arrosé; n° 2, destiné à recevoir 7,500 mètres cubes par hectare; n° 3, 15,000 mètres cubes; n° 4, 22,000 mètres cubes.

Le produit du n° 2 fut employé en vert à l'engraisement

(1) *Journal of the Royal Agric. Society*, t. XIII.

des bœufs; le produit du n° 3, pour les vaches laitières, et le produit du n° 4 fut récolté à l'état de foin.

Les expériences qui avaient donné un résultat peu avantageux pendant la première année (1861), ont été poursuivies en 1862 et en 1863. Nous résumons les conclusions importantes auxquelles elles ont donné lieu (1) :

Dans les premiers essais, il avait été constaté :

1° Qu'un hectare de prairie non fumé avait suffi à l'alimentation pendant 50 semaines d'une vache qui avait donné du lait dont la valeur, calculée à 0,18 le litre, représentait une somme de fr. 695

2° Un hectare de prairie arrosé avec 3,750 mètres cubes d'eaux d'égout, avait suffi à l'alimentation pendant 100 semaines d'une vache qui avait produit en lait une somme de . . . fr. 1,175

3° Un hectare arrosé avec 7,500 mètres cubes avait alimenté une vache pendant 145 semaines et représentait . . . fr. 1,690

4° Un hectare arrosé avec 11,500 mètres cubes, avait nourri une vache pendant 170 semaines, soit fr. 1,975

1. *Irrigation des prairies.* — L'arrosage pendant les mois d'hiver donne un herbage relativement précoce, mais le rendement est faible par rapport au volume d'eau consommé.

L'arrosage, en raison de l'eau employée, permet de prolonger la durée de la récolte jusqu'au commencement de l'hiver.

Sur une moyenne de trois ans et sur les deux lots de 4 et 2 hectares, le rendement par hectare et par an a été le suivant :

ACCROISSEMENT PAR 1000 M. C. D'EAU.		FOURRAGE VERT.	FOIN.
"	Terrain non arrosé . .	23,15	7,50
12,50 %	Id. arrosé avec 7500 m ³	55,60	12,50
10,50	Id. id. id. 15000 m ³	75,60	14,40
8,10	Id. id. id. 22500 m ³	81,25	16,25

(1) *Third Report of the Commission, etc., 1865.*

Le rendement le plus considérable a été obtenu la troisième année, avec un volume d'eau de 22,500 mètres cubes par hectare; soit, 87,5 de fourrage vert égal à 6,740 kil. de foin et 92,50 de fourrage égal à 7,160 kil. de foin. L'accroissement de produit, pour un volume d'eau donné, a été en revanche moins considérable sur les compartiments où le volume le plus considérable avait été déversé.

2. *Engraissement.* — Les bœufs consomment (en vert) plus de fourrage arrosé que de fourrage non arrosé; mais comme matière sèche, c'est l'inverse qui a lieu. Ces résultats se rapportent à des bœufs consommant des poids égaux de fourrage et augmentant, dans la même période de temps, d'un poids donné. Cette condition nécessite l'emploi à l'étable d'une certaine quantité de tourteaux, indépendamment de l'alimentation en vert.

Les vaches laitières, pouvant manger à volonté de l'un ou de l'autre fourrage vert, profitent plus, comme augmentation de poids et comme rendement en lait, avec le fourrage non arrosé. Mais relativement à un poids déterminé de matière sèche, le rapport est inverse.

Le rendement en lait varie suivant les saisons et pendant une même saison. En moyenne, six parties en poids de fourrage arrosé ont rendu une partie de lait, en poids. L'irrigation permet, en prolongeant la durée de l'alimentation des vaches sur un hectare, de tripler et de quadrupler le produit en lait. Sur un hectare de prairie arrosé avec 12,500 mètres cubes d'eau, le produit brut est d'environ 4,550 litres de lait.

Le ray-grass, cultivé pendant une saison seulement, a donné un produit plus considérable à l'hectare pour un volume d'eau déterminé, que les prairies permanentes. Le produit brut par hectare, de ray-grass ayant reçu 12,500 mètres cubes d'eau, équivaut à 1800 francs.

3. *Composition des eaux de drainage.* — L'analyse des eaux, après leur infiltration dans le sol, démontre que les éléments fertilisants les plus précieux ont été fixés par le sol, mais qu'une seule immersion ne suffit pas pour enlever la totalité des principes nuisibles. Il faut donc, quand on emploie des

grandes masses d'eau, les faire servir au moins deux fois de suite à l'arrosage.

4. *Composition du fourrage.* — Le fourrage arrosé, donné en vert au bétail, renferme moins de matière sèche que le fourrage non arrosé. L'herbe coupée à la fin de la saison est moins succulente, dans les deux cas, que celle de l'été ou de l'automne.

La proportion de matière azotée est plus considérable dans la matière sèche du fourrage arrosé que dans l'autre, et à la fin de la saison qu'au commencement. La matière ligneuse est en égale proportion dans les deux cas.

Le rendement en lait, qui a été trouvé plus considérable pour un poids déterminé de matière sèche du fourrage arrosé, paraît tenir surtout à des conditions différentes de maturité, de digestion et d'assimilation.

5. *Action des eaux sur les plantes des prairies.* — Les eaux d'égout développent les graminées jusqu'à l'exclusion des légumineuses et des parasites; elles favorisent la végétation des espèces suivantes : *peturin commun*, *chien-dent*, *dactyle*, *houque laineuse*, *ray-grass vivace*; mais deux ou trois espèces seulement subsistent après un arrosage de quelques années.

6. *Composition du lait.* — Le lait des animaux nourris avec du fourrage arrosé, offre peu de différences à l'analyse, au point de vue de la caséine, du beurre, du sucre et des cendres. L'addition des tourteaux augmente beaucoup sa richesse.

7. *Arrosage de l'avoine.* — Dans un premier essai sur de l'avoine à laquelle on avait appliqué 340 mètres cubes à l'hectare, l'augmentation du produit fut trouvée égale à 0,50 par mètre cube d'eau. Dans un deuxième essai, avec 1300 mètres cubes, l'augmentation ne fut que de 0,15. Il est vrai de dire que, par suite de la saison pluvieuse et de la faible teneur des eaux, ces essais n'indiquent pas exactement ce que l'on peut attendre de l'arrosage très-modéré des céréales.

RÉSULTATS AGRICOLES DE L'IRRIGATION.

Les expériences de Rugby sont concluantes, car elles confirment les résultats de la pratique des irrigations dans les

autres localités et précisent le volume d'eau nécessaire et les cultures auxquelles ce mode de fertilisation est applicable dans les conditions ordinaires des terres arables par opposition aux sables proprement dits.

Les calculs théoriques que nous avons cités dans un chapitre précédent, sur la valeur pécuniaire des eaux d'égout sont ainsi en contradiction avec les données de l'expérience. Cette valeur sous le rapport agricole, dépend d'une foule de circonstances qui varient dans une même localité. Ce que l'analyse la mieux raisonnée indique comme devant représenter un accroissement de valeur à l'hectare de 4000 à 5000 francs, ne représente réellement, dans le cas d'Edimbourg, après des arrosages qui ont duré 30 ans en moyenne, qu'une augmentation de 1200 à 1500 francs. Le prix de 0,15 à 0,20 assigné par l'analyse au mètre cube d'eaux, descend donc, par le fait de l'expérience agricole, à 0,05 et 0,10. Si le sol est léger et que l'on puisse faire consommer au bétail le produit des prairies, c'est-à-dire une quantité considérable de fourrage vert, la valeur de l'engrais liquide des égouts augmente. Si, au contraire, l'on est obligé de faire du foin (ce qui n'est pas sans difficulté sur des prés arrosés), la valeur de l'engrais liquide diminue sensiblement. Enfin, si l'on n'a pas de prairies, il y a le plus souvent intérêt à ne pas employer l'engrais sous cette forme.

Les sols sableux se prêtent le mieux à l'arrosage continu, par la raison que la couche de terre arable y augmente utilement chaque année. Les sols argileux et secs, sont, à l'inverse, moins bien appropriés, parce que, malgré leur pouvoir d'absorption et le drainage, ils ne se laissent pas pénétrer par le liquide qui coule à leur surface et parfois les dépouille de certains principes essentiels, tels que la potasse. Dans les terres fortes, le fumier le plus pauvre exerce une action mécanique non moins utile que l'action chimique, car il leur donne de la porosité; l'air y trouve accès de plus en plus facilement et les récoltes s'améliorent par le fait unique d'une meilleure condition physique. Aussi, n'hésitons-nous pas à croire que dans les sols compacts, où l'application de l'engrais liquide a donné de bons résultats,

il convient de les attribuer à l'influence de l'eau, à certains moments de la végétation, plutôt qu'à la proportion de matières fertilisantes que tient cette eau.

Quand on fume avec des fumiers, des engrais spéciaux ou par le paturage des moutons et des bêtes à cornes, on met l'engrais où l'on veut et l'expérience démontre que cet engrais est utile sur le point où il est placé. Avec l'engrais liquide, on n'est pas maître de la distribution; il pénètre sur les terrains ordinaires dans toute la masse superficielle et pour obtenir des effets sensibles, il faut augmenter énormément le volume des eaux. Si l'on pouvait extraire d'un mètre cube de liquide, le kilogramme ou les 2 kilogrammes de matières solides qu'il contient et les appliquer à la surface, on rentrerait dans les mêmes conditions et on obtiendrait les mêmes effets immédiats qu'avec l'engrais solide; mais ces 2 kilogrammes sont noyés dans 1000 kil. d'eau. Aussi, l'arrosage avec 750 ou 1000 mètres cubes à l'hectare de prairies, n'avance à rien; tandis que l'épandage de 2000 mètres cubes à l'hectare active la végétation. Cette considération est donc toute à l'avantage des eaux d'égout dont on dispose en grandes masses et en défaveur des engrais liquides obtenus en trop petites quantités dans les exploitations. L'évaporation avec de grandes masses de liquides devient considérable; l'eau, parvenue à une grande profondeur relativement, revient à la surface par l'action de la capillarité, et les racines utilisent les matières en dissolution. On calcule ordinairement sur une dépense de 30 à 50 francs de guano par hectare, mais il peut convenir à un fermier de payer 750 francs pour arroser un hectare avec 15,000 mètres cubes d'eaux d'égout au prix de 0,05 le mètre cube, parce que ce fermier, comme à Edimbourg, retire de 1,800 fr. à 2,000 fr. de produit de cet hectare au lieu de 60 à 100 fr., qu'aurait produit sa fumure au guano. D'ailleurs, la pratique est là pour décider qu'il est préférable d'utiliser le volume d'eau maximum. En effet, partout où la canalisation avait été trop étendue au début (système tubulaire), on a dû diminuer la surface arrosable. A Rogby, M. Walker, qui avait installé l'irrigation sur 180 hectares de terres arables et de prés, n'arrose plus aujourd'hui que quelques

hectares exclusivement en prairie. A Watford, la canalisation établie par lord Essex sur 80 hectares pour y distribuer les eaux d'une population de 4,000 habitants sert aujourd'hui à répandre le même volume d'eau sur 4 hectares de ray-grass pendant l'été et de 12 à 15 hectares de prairie en hiver.

M. Lawes estime que l'application de 20,000 mètres cubes par hectare assure aux prairies un produit de 1,500 francs. Sur un hectare lourdement fumé en engrais solide, le produit par hectare s'est élevé à 30 tonnes de fourrage vert et par l'épandage des eaux d'égout, de 22 à 50 tonnes. Il est donc évident, puisque le but final de l'arrosage est de produire du lait et de la viande, que pour les exploitations ordinaires, il est préférable d'utiliser le plus grand volume d'eau sur une surface moindre de prairies, afin d'employer le fumier du bétail sur le reste du sol cultivé, comme à l'ordinaire.

En tous cas, l'irrigation ne peut être continue et permanente, qu'à la condition de changer le système de culture et l'assolement adopté. En effet, si on admet que le terrain soit disposé pour l'irrigation et que l'assolement soit continué, il y aura des époques de l'année (les mois pluvieux) où l'eau, quel qu'en soit le prix, devra être refusée; et ces époques coïncideront pour tous les fermiers d'un même district. En 1862, la température fut si basse, que les eaux n'avaient aucune valeur; on obtint des récoltes considérables de fourrage par suite des pluies, mais ils étaient de qualité inférieure; la végétation s'était faite trop lentement pour que la maturité fût complète. Il y a donc à tenir compte de la saison et de la température moyenne pour assigner plus ou moins de valeur à l'eau d'arrosage. Pour certaines récoltes, les racines par exemple, on ne peut arroser, pendant la plus grande partie de la végétation, qu'au détriment de la récolte.

S'il était possible d'arroser aujourd'hui et de cesser demain à volonté, toutes les récoltes seraient utilement arrosables. Or, le problème posé n'admet pas une solution de ce genre; les liquides des égouts ne peuvent être emmagasinés, et force est, pour l'assainissement des centres de population, de les enlever sans délai. Le service des eaux affectées à l'arrosage des

céréales, des racines, des légumineuses, des prés mêmes où l'on fauche le foin, ne peut donc être qu'accessoire ou accidentel, bien qu'important au point de vue du bénéfice. A défaut de sables ou de terres légères, l'irrigation continue n'est possible que sur des prairies permanentes ou artificielles, convenablement drainées.

VII. — CONCLUSIONS.

Il résulte de l'ensemble des faits que nous venons d'exposer, les uns d'après les enquêtes officielles, les autres d'après nos visites sur les lieux, que des deux systèmes en présence, le premier a pour objet de désinfecter les eaux des égouts avant de les perdre à la rivière; le second d'utiliser ces eaux à l'état naturel, à l'arrosage des terres stériles et en culture, afin de les désinfecter. Ces deux systèmes se rattachent à une même école qui demande que les égouts entraînent non seulement les eaux pluviales et ménagères, mais aussi les déjections, c'est-à-dire qu'on supprime les fosses d'aisance, les puisards, etc.

Premier système. — Les conclusions relatives au premier système dont nous avons décrit les applications sont les suivantes :

1° Parmi les procédés expérimentés, aucun n'est applicable à toutes les villes; mais il est possible après quelques essais, de diminuer économiquement les inconvénients qu'offre l'écoulement des eaux sales dans les rivières.

2° Il convient, lorsque des cours d'eau importants reçoivent les égouts de villes peu considérables, de se borner à séparer les matières solides par le repos ou par le filtrage; sans à désinfecter les eaux pendant les mois d'été;

3° La valeur d'un procédé d'épuration dépend non-seulement de la filtration, mais aussi des agents chimiques employés; le filtrage sépare, sans le fixer, l'azote contenu dans les sels ammoniacaux de celui que renferment les matières organiques; tandis que les agents de précipitation fixent l'ammoniaque de la partie insoluble, sans entraîner l'ammoniaque que renferme en beaucoup plus grande quantité la partie soluble;

4° L'emploi de la chaux donne des résultats imparfaits sous le rapport de l'assainissement, puisque les eaux se décomposent de nouveau, et au point de vue agricole, car elle ne fixe qu'un tiers de l'ammoniaque contenu dans les eaux;

5° Les frais des procédés basés sur l'emploi de la chaux artificielle, de la force centrifuge, etc., pour enlever au précipité par la chaux l'excès d'eau qu'il contient, ne sont pas en rapport avec la valeur minime de l'engrais obtenu. La dessiccation n'est possible économiquement que par le mélange immédiat avec des matières absorbantes d'un prix minime;

6° Le mélange avec la chaux d'autres substances telles que le charbon, l'alumine, les phosphates, etc., augmente la dépense sans améliorer proportionnellement le résultat;

7° Le désinfectant reconnu le plus efficace est le perchlorure de fer dont le prix trop élevé jusqu'ici ne permet pas de répandre l'emploi. L'engrais résultant de la précipitation par les sels de fer n'a pas une valeur agricole proportionnelle à son prix de revient.

Deuxième système. — 1° Le procédé, le plus simple et le plus économique à la fois, consiste dans l'irrigation par rigoles de niveau et par déversement, chaque fois que les dispositions du terrain le permettent;

2° Ce procédé, qui permet d'utiliser constamment un débit régulier, comme l'est celui fourni par les égouts d'une ville; donne les meilleurs résultats sur les terrains sableux ou perméables;

3° Pour disposer en toutes saisons et alors qu'elles sont le moins utiles, c'est-à-dire en temps de pluie, des eaux des égouts, il faut recourir à l'arrosage des prairies, de façon à ce que ces eaux se répandent d'une manière continue sur de nouvelles surfaces, jusqu'à épuisement des principes fertilisants;

4° Le drainage est le complément indispensable de l'irrigation sur les sols non sableux;

5° Dans la plupart des cas, l'application pendant l'année de 12,000 mètres cubes d'eau par hectare de prairies, assure un rendement maximum;

6° L'arrosage n'est applicable aux récoltes ordinaires, cé-

réales, racines, légumineuses, etc., qu'accidentellement; il ne peut être continu qu'à la condition de modifier l'assolement adopté, et même, dans ce cas, on ne peut utiliser un volume de plus de 4,200 mètres cubes par hectare et par an;

7° L'irrigation sur les terres fortes ne peut être continuée utilement que si l'on emploie de temps à autre les fumiers qui donnent de la légèreté au sol et des engrais spéciaux qui restituent les principes enlevés par les eaux.

VII. — LONDRES.

Dès 1846, la Chambre des communes était saisie de la question d'utilisation des eaux d'égout sur le sol, et après une enquête (1), elle votait le *Bill* autorisant la formation de la Compagnie *Metropolitan Sewage Manure*, dont nous avons exposé les tentatives infructueuses. Le Rapport établit le fait essentiel que « vu la dilution de l'engrais dans la masse d'eau des égouts, son application au sol offre peut-être moins d'inconvénients que celle des engrais solides. »

Depuis cette époque, le *Board of Health* n'a pas cessé de considérer comme une partie de son programme, l'emploi des eaux d'égout en agriculture. Nous avons signalé dans le cours de ce travail les nombreux essais dus à son initiative et le peu de succès du système tubulaire prôné par ses membres influents. Dans le Résumé des actes de son administration (1854), il ne peut s'empêcher de constater que le système tubulaire est appelé dans bien des localités à exercer une sérieuse influence sur l'agriculture, à développer la richesse fertilisante du pays, et à détruire les graves inconvénients créés par l'insouciance générale; qu'il est regrettable que les Conseils provinciaux ne jouissent pas de pouvoirs assez étendus pour canaliser en dehors des districts soumis à leur juridiction. Il déplore également que dans deux localités on ait eu recours à l'irrigation

(1) *Metropolitan Sewage Manure*, 13 juillet 1846.

par rigoles de niveau (1). Le *Board of Health* se dissout donc sans être convaincu de l'insuffisance de la solution qu'il a proposée.

Le 5 janvier 1857, une ordonnance royale nomme une Commission spéciale de neuf membres, présidée par Lord Essex, pour « rechercher le meilleur mode de distribution et » d'application des eaux d'égout. »

Investie de pleins pouvoirs, cette Commission a remis au mois de mars de cette année, son troisième et dernier Rapport, qui pose les conclusions suivantes :

« 1° Le meilleur mode pour utiliser les eaux d'égout consiste » à les dériver d'une manière continue sur le sol; c'est ainsi » seulement que les rivières pourront être préservées de toute » cause d'infection;

« 2° Les résultats pécuniaires d'une application continue des » eaux d'égout varient suivant les circonstances locales; d'abord, » parce que dans certains cas l'irrigation peut se faire par simple » écoulement suivant la pente du sol, et que, dans d'autres » cas, il faut élever les eaux; et ensuite parce que les terres » fortes (les seules dont on puisse disposer dans certaines » localités) sont moins appropriées que les terres légères à » l'irrigation continue.

« 3° Dans des circonstances favorables, les villes peuvent, » sans grandes dépenses, trouver plus ou moins de bénéfice » dans l'application des eaux. Dans des circonstances défavo- » rables, il peut ne pas y avoir de bénéfice; mais une légère » taxe additionnelle suffira pour couvrir tout excédant de » dépenses. »

Concurremment avec les travaux de cette commission spéciale, dont les Rapports nous ont servi pour notre travail, la Chambre des Communes désignait, le 18 février 1862, un comité composé de 17 membres et présidé par le Dr Brady, « pour » qu'il étudiat les moyens d'utiliser les eaux des villes de l'An-

(1) *Report of the Gen. Board of Health on the administration of the Public health Act*, Londres 1854, p. 22.

« gleterre, en vue de diminuer les taxes locales et de favoriser l'agriculture. »

Ce comité remettait à la Chambre deux rapports en date des 10 avril et 20 juillet 1862, sans apporter aucune solution, ni aucune lumière sur les résultats contradictoires énoncés pendant l'enquête. Aussi, la Chambre nommait-elle, en 1864 (26 avril), un nouveau comité « pour examiner les plans et » projets relatifs à l'emploi agricole des eaux de Londres et « d'autres grandes villes, » mais notamment pour se renseigner sur les travaux et les projets du Conseil des travaux publics de Londres (*metropolitan Board of Works*). Ce comité, composé également de 17 membres, parmi lesquels on compte sir Joseph Paxton, M. Bright, lord Fermoy, présidés par lord Robert Montagu, déposa le 14 juillet suivant, son volumineux rapport qui contient les réponses à 6000 questions et, en appendice, tous les documents, pièces et correspondances à l'appui de l'enquête. Les conclusions de ce Rapport entouré de toutes les garanties que peuvent donner les hommes considérables appelés devant la commission (1), méritent d'être rapportées :

« Le comité a d'abord pris connaissance de tous les plans proposés au Conseil métropolitain des travaux publics et déferés par ordre de la Chambre à son examen. Il s'est fait donner par les ingénieurs les plus éminents du Cornouailles les prix des machines à vapeur et des pompes nécessaires pour élever les eaux à des hauteurs déterminées. M. Bateman, hydraulicien bien connu, a été consulté sur les prix des tuyaux et branchements nécessaires pour la conduite et la distribution sur le sol des eaux d'égout, sur les frais d'assemblage et de pose de ces tuyaux. Le comité conclut de cette première partie

(1) A cette enquête ont été entendus les ingénieurs : Bazalgette, Rawlinson, Bateman, Hopkins, Whitehead, W. West, G. Sheperd, etc. ; les agriculteurs Cuthbert Johnson, Mechi, J. B. Lawes, Congreve, Walker ; le médecin Acland, le chimiste T. Way, le légiste Gail et les promoteurs, capitalistes et ingénieurs des projets déposés devant le Conseil métropolitain des travaux publics.

de l'enquête qu'il est non-seulement possible d'utiliser les eaux des villes en les dirigeant par des drains sur le sol, mais encore qu'une entreprise fondée sur cet emploi peut assurer aux contribuables des avantages pécuniaires. Ce bénéfice peut s'accroître notamment au bout de quelque temps, car les engrais artificiels font défaut et les sources principales de ces engrais seront épuisées dans quelques années. Il faut donc songer à d'autres moyens de fertiliser la terre.

« Le comité, après avoir interrogé le président et l'ingénieur du Conseil métropolitain des travaux publics, pense qu'il aurait pu être fait plus pour utiliser les eaux d'égout de Londres, et que, dès l'achèvement des travaux entrepris par le Conseil, il conviendra d'adopter un système qui transforme les matières insalubres des égouts en une source permanente de fertilité.

« Quand même il n'y aurait aucun avantage pécuniaire, les villes devront prendre les mesures les plus promptes pour détourner les eaux sales des rivières.

« Le comité a interrogé plusieurs personnes sur l'état de pollution des rivières, etc. Il est hors de doute que l'écoulement dans les cours d'eau, où les villes, les villages et les populations des campagnes trouvent leur alimentation, des liquides des égouts et autres immondices, a des effets très-pernicieux. Il est urgent que cet écoulement cesse. Aucun procédé artificiel ne permet d'épurer les eaux souillées par les égouts, de manière à les approprier aux usages domestiques. L'eau ne peut être purifiée qu'en partie par les agents chimiques et mécaniques ; elle est toujours sujette à se corrompre ultérieurement. Les procédés de filtrage et de désinfection ne peuvent donc que mitiger le mal. De l'eau qui paraît pure à l'œil, peut, dans certaines circonstances, créer des épidémies graves, au milieu de la population qui la consomme. Le sol, cependant, et les racines des plantes, ont le pouvoir d'absorber rapidement les impuretés des eaux d'égout et de les rejeter à l'état de pureté.

« M. Pfennell, inspecteur principal des pêcheries, affirme que l'eau des égouts détruit le poisson. En purifiant les cours d'eau, on augmenterait donc la masse des subsistances de la population et le revenu des propriétaires.

« Si l'eau des égouts ne doit plus se perdre à la rivière, il n'y a pas d'autre alternative que de la répandre sur le sol.

« Les tribunaux ont décidé que la décharge des égouts dans une rivière est une nuisance. Mais la loi ne peut pas, faute de pouvoirs plus étendus, faire disparaître cette cause de dommage.

« Il y a trente ans, on utilisait les matières des fosses et les autres immondices, directement sur le sol. De grands obstacles avaient été élevés contre l'établissement dans les maisons de drains communiquant avec les égouts; ceux-ci étaient exclusivement affectés au drainage des eaux de la surface. Le service de vidange était organisé; les maires des villes devaient veiller à ce qu'aucune matière nuisible ou putride fût jetée dans les cours d'eau, les étangs ou les mares. En introduisant l'usage des water-closet et des drains aboutissant aux égouts, les matières fécales ont été rejetées dans les égouts. Or, le transport de ces matières sur le sol est devenu ainsi beaucoup plus facile et plus économique que par le passé, parce qu'elles sont à l'état de suspension dans l'eau.

« Dans beaucoup de villes du Lancashire, où les fosses d'aisances ont été maintenues, à Manchester par exemple, la municipalité dépense 500,000 francs par an, en vidange et en transport et ne retire que moitié de cette somme de la vente de l'engrais. En supprimant les fosses et en exécutant les travaux nécessaires pour transporter les matières liquides sur les champs, ces villes réaliseraient de notables économies.

« Dans l'opinion des commissaires des égouts et du Board of Health, il ne fallait pas perdre de temps pour débarrasser les habitations de l'infection dangereuse, causée par les matières en putréfaction; une fois cette modification exécutée d'urgence, la loi serait respectée en prenant des nouvelles mesures pour protéger les cours d'eau et rendre au sol les déjections.

« La plupart des maisons à Londres et dans les autres villes anglaises, ont été ainsi débarrassées et il en est résulté une infection plus grande des rivières. Ce dernier mal s'étend au fur et à mesure que la distribution d'eau s'améliore, que le drainage des habitations se perfectionne et que la population augmente.... »

Le comité termine en demandant que les pouvoirs donnés par le « Local Government Act » pour la protection des cours d'eau soient étendus aux bassins des rivières, au lieu d'être restreints aux limites des villes, mais que les travaux continuent à être exécutés par les conseils municipaux.

Ces dernières recommandations ne devaient pas être oubliées, car au mois d'octobre de l'année dernière, une députation du Conseil municipal de Sheffield se présentait au Ministre de l'intérieur pour lui demander de présenter à la Chambre des Communes un bill qui empêchât la décharge de toutes matières nuisibles dans les cours d'eau. Le 9 décembre suivant, les corporations de Birmingham, Nottingham, Derby, Wolverhampton, Coventry, Preston et Bath tentaient la même démarche. Le bill fut, en effet, présenté dans la session de l'année courante et développé dans la séance du 9 mars 1865 par le même lord Robert Montagu, qui avait présidé l'enquête de l'année précédente. Mais ce bill pour la « protection des eaux de rivière » fut retiré pour faire place à un autre sur « l'utilisation de eaux d'égout » déposé à l'examen d'un comité spécial. Cette dernière loi votée par la Chambre des Communes est arrivée à la Chambre des Lords, d'où elle sortira à la prochaine session.

Tandis que les enquêtes aboutissaient aux résultats que nous venons d'exposer, le Conseil métropolitain des travaux publics menait à bonne fin les travaux de canalisation autorisés par le « Main Drainage Act » de 1858 et commencés en 1859, sous les ordres de l'ingénieur du Conseil, M. Bazalgette. Ces travaux gigantesques, étudiés d'abord par Foster, l'ingénieur de la Commission métropolitaine des égouts; approuvés plus tard par Robert Stephenson et W. Cubbitt; puis repris et modifiés par l'ingénieur actuel, M. Bazalgette, consistent dans l'établissement de trois collecteurs parallèles dirigés de l'extrême Ouest à l'extrême Est de Londres, qui coupent les égouts existant à angles droits, un peu au-dessous de leur niveau, de façon à concentrer les liquides sur un émissaire situé à 22 kilomètres en aval de London Bridge. Le plus grand volume de liquides est ainsi entraîné par la pente; le reste est élevé par des pompes.

Les réservoirs construits sur les bords de la Tamise, au point de décharge générale, peuvent déverser les liquides, à marée haute, dans le fleuve, de manière à ce que, délayés dans la plus grande masse d'eau possible, ils soient entraînés par le reflux jusqu'à 40 kilomètres en aval de London Bridge et ne puissent remonter par le jusant dans l'enceinte de la métropole. Une série d'essais directs avait en effet démontré que la décharge des liquides d'égout à marée haute, sur un point quelconque du fleuve, dans Londres, représentait la décharge sur un point situé à 19 kilomètres en aval, à marée basse. Ainsi, la construction des 19 kilomètres du collecteur aboutissant aux réservoirs de Barking Creek a eu pour effet de reculer de 38 kilomètres en aval de Londres, le point de décharge générale de la rive nord.

D'après les chiffres du rapport de M. Bazalgette, on conçoit l'importance de l'entreprise à peu près achevée. Londres comprend actuellement 2,100 kilomètres d'égouts et 132 kilomètres de collecteurs. Le « Main Drainage » a nécessité, pour la rive nord seulement, l'emploi de 18 millions de briques, de 70 millions de mètres cubes de béton et le mouvement de 2,600,000 mètres cubes de terre.

La force des machines élévatoires est de 2,350 chevaux-vapeur correspondant à une consommation annuelle de 44,000 tonnes de houille, en admettant un travail de jour et de nuit. Le volume des eaux drainées par les collecteurs de la rive Nord est de 283,000 mètres cubes par jour et de 40,000 mètres cubes pour la rive Sud. Mais les travaux sont calculés en prévision d'un débit de 325,000 mètres cubes d'une part et de 165,000 d'autre part; non compris les eaux d'orage. Au total, les égouts nouvellement construits répondent à un débit de 1,700,000 mètres cubes d'eau par jour.

La dépense totale des travaux, quand ils seront terminés complètement, s'élèvera à 102 millions de francs dont l'intérêt et l'amortissement sont servis au moyen d'un impôt de 0,30 sur les contribuables de Londres, qui représente une somme de 4,500,000 francs correspondant à un capital imposable de 365,000,000 francs. Le capital et les intérêts seront remboursés en quarante ans.

Les trois collecteurs parallèles de la rive Nord aboutissent près de Stratford à la station ou au dépotoir d'Abbey Mills, où les eaux sont élevées à 11 mètres dans le collecteur général qui se rend aux bassins de Barking Creek. Les machines à balancier, d'une force nominale de 1,140 chevaux, font mouvoir quatre pompes; elles sont à condensation et à détente; le diamètre des cylindres est de 1^m,37; la course du piston de 2^m,75; le volume d'eau élevé à 10^m,97 est de 425,000 litres par minute. La profondeur moyenne du réservoir de Barking est de 5^m,15; il est partagé en quatre compartiments qui recouvrent une superficie totale de 4 hectares et peuvent emmagasiner 190,000 mètres cubes. Le tout est voûté et recouvert au dessus de la surface par un remblai de terre qui surmonte de 0^m,60 la clé des voûtes. Les fondations de ce bassin ont dû être portées à une profondeur de 6 mètres de béton, à cause du peu de consistance du sol.

Sur la rive Sud, les deux collecteurs parallèles convergent vers le dépotoir de Deptford Creek, où les pompes élèvent les eaux dans un collecteur général dirigé sur les réservoirs de Crossness. Ce dépotoir renferme quatre machines de 125 chevaux, chacune pouvant élever par minute 283,000 litres à une hauteur de 5^m,50. Le collecteur qui va à Crossness a 3^m,66 de diamètre; il est souterrain sur une longueur de 13 kilomètres, passe sous la ville de Woolwich à la côte de 13 à 25 mètres et débouche au milieu des marais d'Erith dans un réservoir recouvrant 2^{hect},5 de surface et tenant 100,000 mètres cubes. Une autre station à Crossness, la répétition de celle de Deptford, permet de pomper les eaux dans le réservoir qui écoule les eaux à marée haute dans la Tamise.

Nous en avons dit assez pour témoigner de l'intérêt de ces travaux. Sauf le parallèle inférieur de la rive Nord qui longera la Tamise sous les quais en cours d'exécution, l'entreprise gigantesque est achevée.

A peine le Conseil métropolitain mettait-il la main à l'œuvre, qu'il recevait des soumissions pour la concession des eaux aux émissaires de Barking et de Crossness. Le 27 janvier 1860, le Conseil en sollicita d'autres publiquement et le

6 juillet suivant, ces soumissions étaient reçues et renvoyées à l'examen d'un comité spécial qui déposa son Rapport le 3 janvier 1862. Plus tard, sur les conclusions du Rapport de la commission de la Chambre des communes, présidée en 1862 par le Dr Brady, le Conseil métropolitain dut demander de nouvelles soumissions au public, et le 10 juillet 1863, neuf soumissions ouvertes furent renvoyées à l'examen d'un nouveau comité qui remit son Rapport le 29 juillet 1863. Nous résumons les termes de ces diverses soumissions :

1^{re} Le Dr Thudichum propose un système (analogue au système diviseur déjà appliqué à Paris) qui consiste à séparer les déjections liquides des matières solides par une installation mécanique et à les conduire par un égout spécial jusqu'à Barking.

2^e M. Daniel Curwood suggère la séparation des matières solides et liquides.

3^e Lord Torrington, sir C. Fox et M. Thornton Hunt demandent d'employer les eaux à l'arrosage sans indiquer par quel procédé ni quels terrains ils arroseront. Ils se bornent à annoncer leur intention d'acheter les terrains nécessaires à l'irrigation (8 à 10,000 hectares) et d'abandonner au Conseil un tantième pour cent à déterminer sur les bénéfices nets.

4^e M. James Moore propose de prendre au compte d'une Compagnie, *Liquid Sewage Manure*, la totalité des eaux des égouts pour les appliquer à l'agriculture, pendant 90 ans. Le Conseil recevait une redevance nominale pendant les quatorze premières années, et après cette période, la moitié des bénéfices provenant de la vente des eaux, après avoir déduit un intérêt de 10 % sur le capital versé ou tel autre intérêt déterminé par le Secrétaire d'Etat. Plus tard M. Moore annonce qu'il a engagé des traités avec des propriétaires possédant 25,000 hectares environ et offre de payer 1 centime par mètre cube d'eau élevé à 60 mètres; ce qui, d'après son calcul, correspondrait pour 360,000 mètres cubes d'eau par jour, à un revenu annuel de 3,400,000 francs.

5^e M. Georges Sheperd, au nom d'une Compagnie s'intitulant *London and Provincial Sewage*, demande la jouissance des eaux pendant 50 ans, moyennant un intérêt garanti de 7 1/2 % par

an du capital employé; au-delà de ce tantième, les bénéfices seraient également partagés entre la Compagnie et le Conseil. Après 50 ans, la Compagnie ne recevrait plus pour son capital qu'un intérêt de 5 %, avec partage égal des bénéfices.

6^e M. Townsend, au nom d'une Compagnie *London Sewage Utilization* demande qu'on lui concède pour deux années, au prix annuel de 105 francs, le volume d'eaux qui lui serait nécessaire, et si ses expériences réussissaient, qu'on étende la concession à 21 ans; enfin, qu'après ce délai, la Compagnie paye le prix convenu à l'amiable entre les parties, ou fixé par arbitrage.

7^e M. Charles Kirkman expose qu'il a inventé un système de désinfection et d'emploi des eaux, qu'il développera devant le Conseil avec des plans à l'appui, moyennant une rétribution suffisante; plus tard, il fait connaître son procédé fondé sur la décantation et le filtrage des eaux. Une usine sera construite à Barking Creek, à la condition que le Conseil concèdera le terrain nécessaire autour du réservoir, la jouissance des eaux et des quais; pendant les sept premières années, moyennant une redevance nominale; pendant les sept années suivantes, moyennant l'abandon d'un cinquième du bénéfice, après déduction d'un intérêt de 20 % sur le capital versé. M. Kirkman garantit le paiement d'une somme minimum de 250,000 francs par an et est prêt, deux ans après en avoir reçu la notification, à consigner l'usine au Conseil, à la condition que le capital dépensé lui soit remboursé, plus une prime de 25 % sur ce capital et 1 % de redevance pour l'usage de son brevet.

8^e M. Ellis, au nom d'une Compagnie en formation (*London and Provincial Towns Sewage Irrigation*) offre de prendre les eaux des égouts de Londres aux réservoirs ou aux émissaires, de les élever par des pompes, sur les deux rives de la Tamise, à des niveaux suffisamment élevés pour les distribuer. Les eaux, avant d'être appliquées à l'irrigation, seraient désinfectées, si le Conseil l'exigeait. Le Conseil aurait la faculté de suspendre l'arrosage, quand il jugerait qu'il y aurait insalubrité. Si, dans le cas d'accident aux machines ou autrement, la Compagnie ne pouvait appliquer la totalité des eaux, elle serait autorisée à

les déverser dans le fleuve après les avoir désinfectées ou épurées. Sur les bénéfices de la vente des eaux, la Compagnie recevrait un intérêt privilégié de 5 % pour le montant du capital versé; le reste serait également partagé entre elle et le Conseil. La direction serait confiée à un comité, dont la moitié des membres seraient élus par les actionnaires, l'autre moitié parmi les membres du Conseil métropolitain. La concession des eaux serait faite à perpétuité.

M. Ellis a développé ses propositions avec un devis pour l'installation et un aperçu des frais d'exploitation et des bénéfices.

9^e Enfin, l'honorable William Napier et M. Hope se sont offerts, pour compte d'une compagnie intitulée : *Metropolis sewage and Essex Reclamation*, de prendre les eaux des égouts de la rive Nord de Londres et de les appliquer à l'irrigation de 8,000 hectares de sables, sur la côte du comté d'Essex. Les frais de premier établissement pour l'exécution de leur projet sont évalués à 50 millions de francs; ils proposent d'obtenir du Parlement un acte qui constitue la société et leur permette de faire souscrire le capital nécessaire, en même temps que d'acquérir les terrains et les eaux appartenant à la Couronne et au Conseil métropolitain.

Le Compagnie recevrait les eaux des égouts de la rive Nord au dépotoir d'Abbey Mills et les conduirait par un collecteur voûté de 70 kilomètres de longueur, jusqu'aux Maplin Sands d'une part et aux Dengie Flats d'autre part. Ce collecteur, de 3 mètres de diamètre, serait établi sur six kilomètres et demi, à partir du dépotoir, avec une pente limite de 0^m,40 par kilomètre, jusqu'à un point où il serait nécessaire d'élever les eaux à 6 mètres. De là, le collecteur de mêmes dimensions, serait poursuivi tantôt en remblai, tantôt en déblai, mais avec la même pente, jusqu'à Battle Bridge, où commence la navigation de la rivière Crouch, à 45 kilomètres de distance du dépotoir; à Battle Bridge, les eaux seraient élevées à 3^m,65, dans le but d'augmenter la vitesse du courant et se distribueraient par deux branchements de dimensions moindres le long des rives de la Crouch. Le collecteur de la rive Nord, d'une longueur de 29 kilomètres, aboutit aux terrains *Dengie Flats*; celui de la rive

sud, de 26 kilomètres de longueur, se rend aux *Maplin Sands*. Ces deux localités représentent des relais de la côte d'Essex, mis à sec à marée basse sur plusieurs kilomètres de largeur et sur 32 kilomètres de longueur. Ces immenses plages seront facilement défendues contre l'invasion de la mer par des digues semblables à celles qui ont servi à créer les polders de la Flandre et les watrings du nord de la France. On compte garantir ainsi 3,000 hectares d'abord et finalement 8,000 hectares sur lesquels les eaux des égouts de la rive droite de Londres seront déversées par des rigoles de niveau, comme à Craignieny, de manière à augmenter chaque année leur fertilité et après un certain temps à transformer par le colmatage ces surfaces stériles en pâturages d'un revenu considérable.

Bien que ces sables puissent absorber la totalité des eaux, les soumissionnaires proposent, sur un tiers du parcours du collecteur qui se trouve à un niveau suffisamment élevé, de construire de petits réservoirs ou toutes autres installations nécessaires pour l'arrosage permanent ou intermittent des terres situées à droite et à gauche du collecteur. L'arrosage peut s'opérer ainsi par déversement sur 32,000 hectares de terres cultivées et, au besoin, au moyen de machines élévatoires, cette surface peut être considérablement développée. Les plages de Maplin absorberaient tout ce que la consommation refuserait.

D'après les calculs des ingénieurs Hemans et Bateman, le capital requis pour endiguer les relais, construire des collecteurs, élever les eaux aux deux stations intermédiaires, installer les rigoles d'irrigation, etc., est de 52 millions de francs.

Ce dernier projet, sur un rapport favorable de l'ingénieur Bazalgette, avait déjà été accepté le 10 janvier 1862 par le Conseil, mais sur les conclusions du comité de la Chambre des communes demandant l'ajournement de toute solution, jusqu'à plus amples informations, les concessionnaires, qui n'avaient pas encore déposé leur cautionnement ne signèrent pas de traité.

Le 15 novembre 1864, le Conseil, statuant sur l'ensemble des soumissions qui lui étaient présentées, adoptait de nouveau le

projet légèrement modifié de sir William Napier et de M. Hope et déferait au comité de drainage la négociation d'un traité définitif pour l'emploi des eaux de la rive Nord.

Les conditions de ce traité figurent dans la loi du 19 juin 1865, qui constitue la Compagnie *Metropolis Sewage and Essex Reclamation*. La durée de la concession est de 54 années.

Durant les quatre premières années, les bénéfices réalisés appartiendront en entier à la Compagnie. A l'expiration de cette période, ils seront répartis, déduction faite des annuités pour les obligations et des frais d'exploitation, de la manière suivante :

- 1° Cinq pour cent d'intérêt au capital actions;
- 2° Au-dessus de 5 jusqu'à 15 %, le partage sera fait par moitié entre la Compagnie et le Conseil métropolitain;
- 3° De 15 à 25 %, un quart reviendra aux actionnaires et trois quarts au Conseil;
- 4° Au-delà de 25 %, le partage se fera encore par moitié.

Après 34 ans, le Conseil métropolitain a le droit, en prévenant deux années à l'avance, de faire réviser ces conditions.

Le capital, autorisé par la loi du 19 juin, pour faire face aux dépenses, s'élève à 52,500,000 francs; mais la Compagnie peut émettre jusqu'à concurrence de 17,500,000 francs d'obligations. Le capital actions est réparti en 24,000 titres ou certificats de 2,500 francs chacun qui seront subdivisés, après libération, en actions de 250 francs.

La Compagnie a par la loi, tous pouvoirs pour faire les travaux d'endiguement, de dérivation, de conduite, de drainage et d'irrigation, sous la surveillance des commissaires des égouts; d'affermir, d'hypothéquer, de vendre ou d'échanger tout ou partie des terres conquises sur la mer. Elle reçoit à Barking-Creek les eaux d'égout à un niveau minimum de 1^m,83 au-dessus de l'écluse de Trinity (Londres), sans payer aucun intérêt au Conseil sur les 75 millions qu'ont coûté les collecteurs aboutissant à Barking.

Le volume des eaux que la Compagnie devra enlever ne pourra excéder 340,000 mètres cubes par 24 heures.

D'après un marché passé avec le principal entrepreneur des collecteurs de Londres, les dépenses de construction de l'aqueduc

principal (3 mètres de diamètre sur 60 kilomètres de longueur) conduisant à Maplin Sand, y compris les réservoirs des stations, les pompes, les prises d'eau, les regards, etc., s'élèveront à fr. 46,161,000

Les sommes à verser par les actionnaires de la Compagnie aux concessionnaires, à 750,000

Les acquisitions de terrains, les frais d'études, d'actes, d'administration, etc., plus l'intérêt à 5 pour 100 par an du capital social pendant les trois ans que durera la construction, à 13,069,000

Fr. 60,000,000

La Compagnie pourvoira, par un emprunt de 7 millions et demi, à ce qui manque à son capital de 52 millions et demi.

D'ailleurs, la Compagnie, en se basant sur les résultats agricoles déjà constatés et sur le prix de 0',10 à 0',20 assigné par les agriculteurs au mètre cube d'eaux d'égout et dans l'hypothèse d'un emploi de 120 millions de mètres cubes d'eaux par an, compte réaliser annuellement un bénéfice de 18 millions de francs, à partager, comme il a été stipulé, avec le Conseil métropolitain. La dépense annuelle ne dépasserait pas, dans son estimation, le chiffre de 1,250,000 francs.

Quelque exagération que présentent ces chiffres, la Compagnie aurait, à notre avis, résolu le problème au-delà de toutes espérances, si elle pouvait, à l'expiration de sa concession, payer un intérêt de 10 pour 100 à ses actionnaires, au lieu du taux de 34 pour 100 énoncé dans ces circulaires. Il y a, en effet, à tenir compte dans ces appréciations d'une foule d'inconnues que la pratique seule peut permettre de déterminer avec certitude; une des plus importantes est la constitution même des 8000 hectares de sable, arrosés jusqu'ici par la mer, et sur lesquels les prairies permanentes ne pourront qu'à la longue atteindre un degré de fertilité comparable à celui des prés de Craignintenny.

D'après nos dernières informations le capital de la nouvelle Compagnie vient d'être souscrit et les travaux pour lesquels la

loi accorde un délai de dix ans, ne tarderont pas être commencés. Les concessionnaires ont annoncé qu'ils seront terminés en trois ou quatre ans : d'ici là, ils se proposent de faire des essais en grand, au fur et à mesure de l'avancement du conduit principal.

IX. — PARIS.

Par la création de la Compagnie *Metropolis Sewage*, Londres a résolu la question sanitaire et la question agricole, du moins pour la partie la plus importante de ses égouts. Le système assainissement et restitution inauguré par le *Board of Health* est complet aujourd'hui. Plus de fosses d'aisances, plus de dépotoir, plus de voirie; toutes les immondices de cette immense agglomération sont entraînées, sans offenser la vue ni l'odorat, par les eaux distribuées en abondance dans chaque maison et sur la voie publique, puis finalement rejetées, loin des murs, sur les terres en culture ou sur des plages stériles qu'elles transformeront bientôt en vastes prairies. Ces prairies, à leur tour, fauchées quatre ou cinq fois l'an, enverront sur les marchés la nourriture verte nécessaire aux vaches laitières et à l'engraissement des bœufs qui alimentent la grande capitale.

Ainsi, la loi du *circulus* formulée par Pierre Leroux est réalisée!

Paris, au contraire, est encore aujourd'hui dotée de tous les inconvénients inhérents aux fosses d'aisance, sans offrir, on peut le dire, qu'une très-faible compensation sous le rapport agricole. Malgré tous les efforts tentés par l'administration éclairée qui gère les intérêts de cette ville tant vantée par « la splendeur de ses monuments, la culture des arts, les merveilles de l'élégance et du goût », l'assainissement reste ce qu'il était, au point de vue du maintien des vidanges à ciel ouvert et de l'infection de l'atmosphère et des eaux qui coulent dans Paris.

Les règlements de police ont d'abord exigé que les fosses fussent étanches, puis que les matières y fussent désinfectées

avant leur extraction (1); enfin, ils ont autorisé les entrepreneurs et les propriétaires à transporter les matières solides dans les locaux indiqués, en enjoignant d'écouler les liquides, après désinfection, sur la voie publique, sinon de les emmener directement au dépotoir de la Villette (2). De ce dépotoir, où viennent se déverser journellement dans des réservoirs voutés les tonneaux de vidange, les matières sont refoulées par une pompe à vapeur jusqu'à la nouvelle voirie de Bondy, située à 10 kilomètres de distance.

En même temps, un décret du 26 mars 1852 prescrit la projection directe dans les galeries d'égout des eaux pluviales et ménagères de chaque propriété. En conséquence, les propriétaires ont eu à établir, avant 1862, du pied de la façade de leurs bâtiments à l'égout voisin, des galeries transversales pour y déverser les eaux domestiques; l'écoulement sur les trottoirs a été supprimé.

En 1854, le Conseil de salubrité de la Seine, pensant que la désinfection était « définitivement passée de la théorie dans la pratique » et qu'un des moyens de la faciliter était la séparation des matières dans les fosses, faisait rendre une nouvelle ordonnance (3) d'après laquelle il était enjoint aux propriétaires de faire établir des murs pour cette séparation, dans toutes les fosses fixes ou mobiles. Cette ordonnance qui régit encore les vidanges, maintient l'écoulement direct et permanent des liquides des fosses préalablement désinfectés par les galeries souterraines ou par des tuyaux extérieurs aboutissant à la bouche de l'égout le plus proche, et exige que les propriétaires conservent dans les fosses, le vide nécessaire pour l'introduction et le brassage des matières désinfectantes.

Le Conseil a été tellement convaincu de l'efficacité de la séparation des matières denses pour l'assainissement des habitations, qu'il s'est appliqué à étendre l'emploi d'appareils

(1) Ordonnance du 12 décembre 1849.

(2) Ordonnance du 18 décembre 1850.

(3) Ordonnance du 29 nov. 1854.

diviseurs, mais sans grand succès; ce qui ne l'empêchait pas de déclarer que « les vidanges, telles qu'elles se pratiquent en » suivant les prescriptions de l'ordonnance de 1854, ont reçu » toutes les améliorations compatibles avec l'état de choses » existant. S'il insiste sur le maintien provisoire de cet état de » choses, c'est que la pratique, ici d'accord avec la théorie, » lui donne raison et que les critiques dont il a pu être l'objet » n'ont apporté pour le remplacer que des systèmes plus ou » moins réalisables (1). »

M. le préfet de la Seine ne paraît pas partager entièrement l'avis du Conseil sur l'inutilité de nouvelles modifications dans le service des vidanges, quand, dans son premier mémoire sur les Eaux de Paris, il constate que « les procédés de désinfection » qu'on emploie n'empêchent pas une odeur fétide de se répandre dans les rues. Les liquides plus ou moins saturés » de substances neutralisantes, dont on croit pouvoir tolérer » l'écoulement dans les ruisseaux sous la foi de cette opération » préliminaire, promènent au loin leurs émanations nauséabondes et vont ensuite exciter par leur mélange avec les » résidus de toute espèce qu'entraînent les égouts souterrains, » une fermentation dont l'effet est de rendre plus intenses et » plus délétères les vapeurs qui s'en échappent. L'arrivée de » 200 voitures descendant chaque nuit dans la ville pour enlever le surplus des matières extraites des fosses, le travail » nocturne des vidangeurs, le chargement des tonneaux, le » retour de ces foyers ambulants de miasmes insalubres à la » Villette, emplissent Paris de bruit et vicient l'air qu'on y » respire. »

Pour compléter ce tableau, M. le préfet ajoute : « A certaines » heures, on dépose les ordures et les immondices des maisons » sur la voie publique. Trop souvent les pieds des chevaux et » les roues des voitures les dispersent; il faut les balayer pour » les remettre en tas et les charger sur des tombereaux. Afin

(1) *Rapport général sur les travaux du Conseil d'hygiène publique, etc.*, de 1849 à 1858, par Ad. Trébuchet. Paris, 1861, p. 93 et 94.

» de mieux assurer la propreté et l'assainissement de la ville, » ne pourrait-on pas ouvrir dans les cours des maisons des » trémies par lesquelles toutes ces saletés seraient descendues » dans les galeries où l'on recueillerait, pour le transporter au » loin, ce que les chasses d'eau ne suffiraient pas à enlever? » On ne rencontrerait plus alors ces tombereaux sordides » et infects qui s'arrêtent à chaque pas, interrompent la course » des autres voitures, et répandent, sur leur route, les débris » sans nom qu'ils contiennent et les émanations révoltantes » qui s'en exhalent. »

Malgré ces suggestions, très-hardies apparemment, l'état de choses ainsi stigmatisé par le chef de l'édilité parisienne, subsiste sans modification, à moins qu'on ne considère comme une amélioration, lorsque le choléra vient faire heureusement une courte visite dans la capitale, d'interdire le coulage des eaux vannes (désinfectées) à l'égout. Comme si, en présence de la vidange pratiquée sans écoulement, de l'enlèvement des immondices tel qu'il s'opère chaque jour et au moment où l'on dispose de 20,000 mètres cubes d'eau pure, en plus de la consommation habituelle, cette mesure isolée pouvait exercer une influence sérieuse sur la santé générale!

Sous tous les autres rapports, Paris a fait des pas énormes dans la voie de l'assainissement; personne ne saurait le contester. Le plan grandiose conçu en haut lieu et très-habilement interprété et exécuté par le préfet, a transformé complètement l'aspect de la ville et les conditions d'aération de quartiers entiers. En dehors des travaux d'embellissement, les larges voies nouvelles, les plantations, les squares, les parcs-promenades, le drainage et le pavage des chaussées, etc., concourent au même but : la ventilation et la purification de l'atmosphère.

Sous le rapport des eaux, des établissements hydrauliques ont été construits en amont des égouts pour permettre, par de nombreuses fontaines et des bouches sous trottoirs, d'étendre les services publics d'arrosage et de lavage. En attendant que les eaux de la Marne soient dérivées et que le grand aqueduc de la Somme-Soude vienne jeter dans la consommation plus de 60,000 mètres cubes d'eaux potables, les eaux des sources de la

Dhuis ont été conduites à Paris par un aqueduc de 135 kilomètres, et les quartiers hauts ont déjà à leur disposition 20.000 mètres cubes d'eaux fraîches et limpides.

Les travaux de canalisation ne le cèdent en rien comme importance à ceux entrepris pour améliorer la distribution des eaux potables. En 1838, le développement total des égouts de la ville était de 170.000 mètres environ. Les avant-projets présentés à cette époque au conseil municipal, comportaient la construction de 290.000 mètres en plus, représentant une dépense de 40 millions, à répartir, il est vrai, sur un grand nombre d'années. La plupart des égouts de construction urgente, nécessités par l'écoulement des eaux vers un émissaire général, et par l'extension de l'ancien Paris sont achevés, entr'autres, les collecteurs posés sous les grandes voies parallèles à la rivière, qui débouchent dans le collecteur général de 6 mètres de diamètre horizontal. Ce dernier coupe, en raccourci, le falte compris entre le pont de la Concorde et le pont d'Asnières et verse à Asnières les produits de la rive droite. Sous peu, il sera rejoint par le collecteur de la rive gauche, qui passera en siphon vers le pont de la Concorde sous le fleuve. Enfin, les îles de la Cité et Saint Louis, drainées à leur tour par un groupe d'égouts, aboutiront également par des siphons aux collecteurs de la rive droite. Pour le cas des grosses pluies seulement, ceux-ci sont en communication directe avec la Seine par des déversoirs; chaque collecteur perpendiculaire aux quais, entraîne également les eaux torrentielles vers ces déversoirs, de sorte que l'inondation superficielle est empêchée. Néanmoins, il n'est pas difficile de concevoir ce qu'est et ce que deviendra pour les localités où il débouche, ce courant épais et noirâtre, représentant actuellement un flot d'environ 1 mètre cube à la seconde. Asnières, hier encore un lieu de villégiature pour la classe moyenne et ouvrière, demain un faubourg de la grande ville, soudé aux habitations somptueuses du quartier Malesherbes et Courcelles, est devenu un foyer d'infection. Saint-Denis, Epinay, Montmorency se plaignent de la rivière boueuse qui passe au dessous d'elles.

De sorte que Paris, qui se donne comme type au monde

entier, tout en maintenant la lèpre de la vidange dans ses murs, a fini par empestier le fleuve qui jadis l'assainissait.

L'administration a étudié toutes les dispositions utiles pour atténuer les causes de cet empoisonnement des eaux et de l'atmosphère. Un bateau-vanne arrête le flot et le change en un courant de fond violent qui affouille les dépôts formés et les chasse devant lui sur un parcours de quelques kilomètres. A l'embouchure en Seine, une grille pendante à contre courant, laisse passer les sables dans le bas et arrête tous les corps flottants que des griffes sans cesse en mouvement permettent de recueillir pour en faire de l'engrais. Plus loin, un barrage à mi-hauteur fait descendre les eaux en cascade et une drague à vapeur enlève les sables amoncelés. Enfin, une hotte, par l'appel énergique d'un foyer à coke, attire les gaz et les brûle.

Mais ces dispositions, qui sont loin de représenter un filtrage même grossier, laissent dans les eaux d'égout toutes les parties fines en suspension et la masse de substances dissoutes, dont le fleuve est impuissant à achever la combustion.

Pour rechercher les motifs qui ont arrêté jusqu'ici toutes les tentatives d'utilisation de ces eaux, il faut envisager ceux qui, dans l'esprit de l'administration, entravent l'écoulement des fosses d'aisance.

1. « Ainsi, l'écoulement direct des matières excrémentielles et des immondices à l'égout aurait pour résultat inévitable l'infection des galeries, dont la pente ne peut être que très-faible, d'après le relief du sol de Paris, et qu'aucune chasse d'eau, si forte qu'elle soit, n'assainit jamais complètement. D'ailleurs, délayées à certains jours par les eaux pluviales et dans tous les temps par les eaux du service public, les vidanges perdraient toute puissance fécondante. »

L'objection tirée de l'infection des égouts n'est pas sérieuse. Paris, est, comme relief, dans une situation peut-être meilleure que Londres. Les égouts y ont, en général, une pente plus forte; leur construction est plus soignée; leurs dimensions moyennes plus grandes; tous les égouts sont rattachés à un ensemble bien mieux étudié qu'à Londres, et dans un temps qui ne peut être éloigné les constructions de l'ancien réseau

auront été ramenées aux différents types de galeries récemment adoptés. Au demeurant, rien n'empêche d'organiser un service de chasse plus puissant et quand bien même ce service ne serait pas suffisant dans certains quartiers exceptionnellement bas, les moyens artificiels de ventilation appliqués avec succès à Londres sont applicables à Paris.

Quant à la dilution des vidanges, elle facilite l'emploi des liquides, non pas au point de vue de la précipitation, ce qui est reconnu à peu près impossible, mais au point de vue de leur utilisation à l'arrosage; la puissance fécondante n'y a que gagné. A Vaujours, les liquides ont dû être étendus de quatre à cinq fois leur volume d'eau pure. Edimbourg, Croydon, Carlisle, etc., arrosent avec des eaux qui tiennent en moyenne 2 grammes de matières solides par litre, tandis que les liquides troubles de Bondy en renferment 27 grammes, et les liquides des bassins, après le dépôt des matières pour la fabrication de la poudrette, 12 grammes.

2. « L'Administration a pensé qu'il serait possible de retenir dans les fosses sans aucun déchet et d'y ramener sous un faible volume d'un transport facile, l'engrais qu'elles renferment. Des appareils ou filtres spéciaux permettraient non seulement de séparer les liquides des matières denses, mais encore de concentrer dans celles-ci toutes les substances chargées de miasmes et les principes fertilisants de ceux-là. Les liquides versés à l'égout seraient rendus ainsi inoffensifs et inutiles. Les résidus solides seraient emportés dans des brouettes ou tinettes, chargées sur des waggonnets qui rouleraient sur les banquettes des égouts jusqu'à l'extrémité de la ville où l'on dirigerait leur contenu sur des fabriques d'engrais. »

Aucun appareil, aucun traitement économique ne justifie la confiance de l'Administration dans les progrès de la science appliquée à la désinfection de ces matières. Aucun engrais ayant une valeur proportionnelle à la dépense faite, ne peut en être extrait à l'aide de réactifs chimiques. Ce problème eût-il été résolu, que l'on s'explique difficilement à qui la manipulation aurait pu être confiée; et comment les galeries à petite section aurait pu se prêter à des manœuvres aussi souvent renouvelées sur des masses aussi considérables des résidus solides?

3. « Enfin, on a songé à supprimer les fosses et à faire aboutir les tuyaux de descente à des conduites spéciales qui trouveraient place dans les galeries et dont le réseau serait soumis à l'action de machines aspirantes et foulantes, comme entre la Villette et Bondy. » Ce système a été exposé en 1837, devant le Conseil de salubrité, par M. Mary, inspecteur-général des ponts et chaussées.

Outre la dépense qu'entraînerait le premier établissement de ces conduites affectées uniquement aux liquides des fosses, on ne voit pas dans quel but on réunirait sur plusieurs points de la ville ces eaux très-riches pour les mettre à cet état à la disposition des agriculteurs. L'expérience du dépotoir de Bondy est là. « Est-ce par suite de la cherté des transports? Est-ce par suite de la quantité d'eau mêlée aux urines que ces liquides ne sont pas recherchés? Faut-il attribuer cet état de choses aux préjugés des cultivateurs des environs de Paris, qui n'ont généralement confiance que dans les boues sortant de cette ville? Ce qui est certain, c'est qu'ils ne font aucun emploi des eaux vannes, et ce qui le prouve, c'est cette grande accumulation de liquides qui se trouve à Bondy et qui sont jetés à la Seine (1). » Voilà pour les liquides qui représentent les 19/20^e des produits des fosses et la partie de beaucoup la plus riche en principes fertilisants!

On sait, d'autre part, de quelle manière barbare les matières solides sont transformées en poudrette. La perte des 7/10^e de l'azote n'est qu'un des inconvénients du procédé suivi pendant quatre et six années consécutives sur les matières pâteuses pour les réduire à l'état pulvérulent. Pendant toute la durée de la dessiccation, la masse est en proie à une fermentation des plus intenses et on y ressent, dans tous les temps, une odeur des plus fétides qui se répand au loin sur la campagne et rend impossible le voisinage de la voirie.

Les industries qui traitent les eaux vannes pour en retirer les sels ammoniacaux ou le phosphate magnésien; les fabriques

(1) Rapport général sur les travaux du Conseil d'hygiène, etc., p. 95.

de chaux animalisée, etc., trouveront ailleurs leurs matières premières.

Au lieu donc de créer de nouveaux dépotoirs, ne conviendrait-il pas de supprimer au plus vite celui qui existe et les dépenses y afférentes.

Dans l'état actuel, le dépotoir de la Villette reçoit annuellement en matières solides ou liquides 250,000 m. c.
On écoule directement dans les égouts environ 200,000

Total, 450,000

Les propriétaires à Paris payent 8 francs en moyenne par mètre cube projeté dans l'égout ou transporté au dépotoir, soit par année 3 600,000 francs.

L'évacuation totale et constante des matières à l'égout, annulerait un impôt aussi excessif, ou du moins le rendrait disponible pour d'autres travaux.

« Si l'on calculait, dit M. le préfet, le temps et l'argent qu'absorbe chaque année l'extraction, la désinfection, le transport des vidanges, le charroi des immondices, le déplacement, le remplacement des pavés, etc., on reconnaîtrait peut-être qu'il en coûte plus pour maintenir un régime que la civilisation désavoue, pour remplir la ville de lourdes et odieuses voitures, d'embarras sans cesse renouvelés, de bruits nocturnes, d'odeurs méphitiques (par lesquels le séjour de la ville devient incommode et insalubre sous prétexte de propreté), qu'il n'en coûterait pour perfectionner, construire, achever une bonne canalisation de Paris; » et nous ajoutons, qu'il n'en coûterait pour rejeter ces précieux produits hors de la banlieue habitée et fertiliser des surfaces consacrées à la culture des produits consommés par la capitale.

Déjà, à l'exemple de Londres, le Conseil supérieur d'hygiène en Belgique, a conclu que l'accumulation dans les fosses, ainsi que la vidange et le transport des matières, par quelque procédé qu'ils s'opèrent, ne peuvent être que nuisibles à la santé publique, et qu'il importe, pour la salubrité comme pour l'agriculture, que ces matières soient dirigées par des canaux hors de l'enceinte des villes.

L'Administration de Paris s'est décidée, il y a quelques jours, à annoncer qu'à peu de distance d'Asnières, elle allait mettre en adjudication les travaux d'un barrage qui, construit dans l'intérêt de la navigation, créera une force hydraulique de plus de mille chevaux, à l'aide de laquelle on élèvera les eaux d'égout, pour en débarrasser définitivement le fleuve et les refouler sur des plateaux sablonneux où elles pourront être utilisées par l'agriculture. Une Commission, composée des agriculteurs et des savants les plus compétents, étudie les moyens d'utilisation de cette richesse.

Le projet dont il est ici question, est sans doute celui dont M. Mille, ingénieur en chef des ponts et chaussées, a indiqué les bases dans diverses publications et notamment dans ses rapports adressés à M. le préfet de la Seine « sur les Irrigations et les Prairies à marcites du Milanais » et sur « Marseille et le Canal de la Durance. »

M. Mille, avec une ardeur et une persévérance dignes de tous éloges, cherche depuis de longues années à vulgariser en France les principes hygiéniques du *Board of Health*. Rien n'a été négligé, dans ses nombreuses visites en Angleterre, en Italie et en Espagne, pour arriver à la connaissance intime des méthodes d'irrigation en usage; pour les essais de Vanjourns avec les liquides de Bondy, M. Mille a voulu assister M. Moll dans tous les détails techniques et pratiques de l'arrosage par le système tubulaire.

Le projet qu'il a étudié pour l'utilisation des eaux d'égout de Paris, d'après ce qui a été publié, se résume ainsi :

Créer par un barrage de navigation placé à Asnières une force motrice de 2,400 chevaux, réduite en effet utile à 1,200 chevaux, pour élever et refouler les eaux à la cote de 40 mètres au-dessus du radier du collecteur; cette cote correspond au col de Sannois où se déprime le faite des collines qui séparent la vallée de la Seine, de celle du lac d'Enghien et de Montmorency. Au pied de ces collines, se trouvent au sud les plaines d'alluvions anciennes, dans lesquelles la Seine serpente trois fois entre Genevilliers et Saint-Germain; et au nord, les sables moyens et la plaine du calcaire grossier perméable de Pontoise. Le canal

d'arrosage atteignant ce territoire pourrait couler partout; il se diviserait suivant trois lignes : la première ascendante, livrée aux eaux forcées, arroserait la plaine de Genevilliers qui comprend plus de 1,500 hectares d'un sol stérile où la culture céréale ne prospère qu'à l'aide des boues et des fumiers de Paris; la seconde, descendante et parcourue par les eaux libres, suivrait la pente du coteau d'Argenteuil, tomberait une première fois à la Seine, à la Prette-sous-Herblay, poursuivrait par un siphon, couperait les garennes sableuses qui terminent la forêt de Saint Germain et enfin se déverserait au point bas d'Andressy, au-dessus de la bouche de l'Oise et en dehors de l'île de France. La troisième branche, se développant sur le revers opposé des collines, irait à l'Oise par la vallée de Montmorency.

Quel que soit le sort réservé à ce projet appliqué à la seule partie des environs de Paris où l'arrosage paraît possible, par suite de la perméabilité des terrains et de l'écoulement des eaux, après désinfection, vers la rivière, il est difficile d'admettre qu'une Compagnie puisse, comme à Londres, se charger d'une pareille entreprise sans avoir préalablement acheté une surface très-considérable, pour utiliser la plus grande partie des eaux et surtout, sans avoir acquis la certitude que les égouts recevront, par suite de la suppression des fosses, les déjections de la population parisienne.

L'administration, qui n'a pas craint de mettre en réserve une somme de sept millions de francs pour couvrir les indemnités d'expropriations et les acquisitions, lorsqu'il s'est agi de construire l'aqueduc de dérivation des eaux de la Somme-Soude, serait plus intéressée et plus en mesure qu'une Compagnie, à assurer par des achats de terrains appropriés, le succès d'une entreprise dont les débuts seront pénibles, en présence surtout de l'élévation mécanique des eaux et du changement radical que l'arrosage devra apporter dans la culture des localités desservies par le canal. Ce n'est qu'à la condition d'irriguer de vastes prairies permanentes ou artificielles que l'on pourra absorber la totalité des eaux d'Asnières; ces prairies sont à créer; les autres cultures céréales ou maraîchères, con-

trairement à ce que M. Mille suppose, et d'après l'expérience acquise aujourd'hui, ne recourront aux eaux que pour des arrosages temporaires, d'une importance minime. En tous cas, sans les matières fécales qui apportent à l'état de dilution des principes essentiels à la fertilité du sol, acide phosphorique, potasse et azote, les irrigations ne sauraient offrir aux fondateurs d'une Compagnie un intérêt de spéculation suffisant, ni une garantie de bénéfice assez sûre pour le capital engagé.

L'adoption du projet de M. Mille entraîne donc, à notre sens, la suppression des fosses et des voiries.

Nous faisons des vœux ardents pour que la commission chargée par la ville d'étudier la question, la tranche au plus vite dans le sens indiqué par la pratique de l'Angleterre et pour que, dans le langage imagé de M. le préfet de la Seine « la statue d'or n'ait pas plus longtemps des pieds d'argile. »

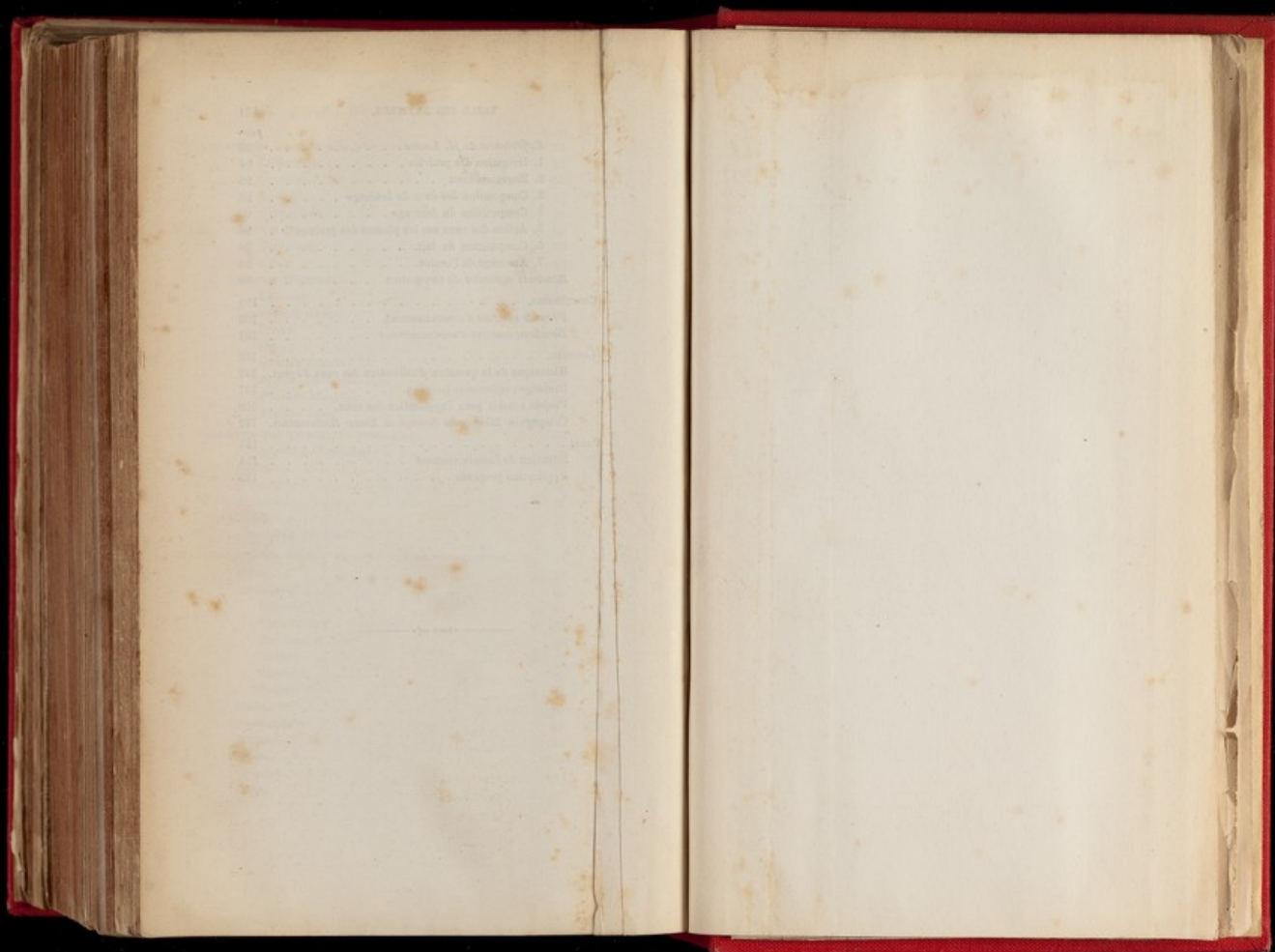
Paris, ce 20 octobre 1865.

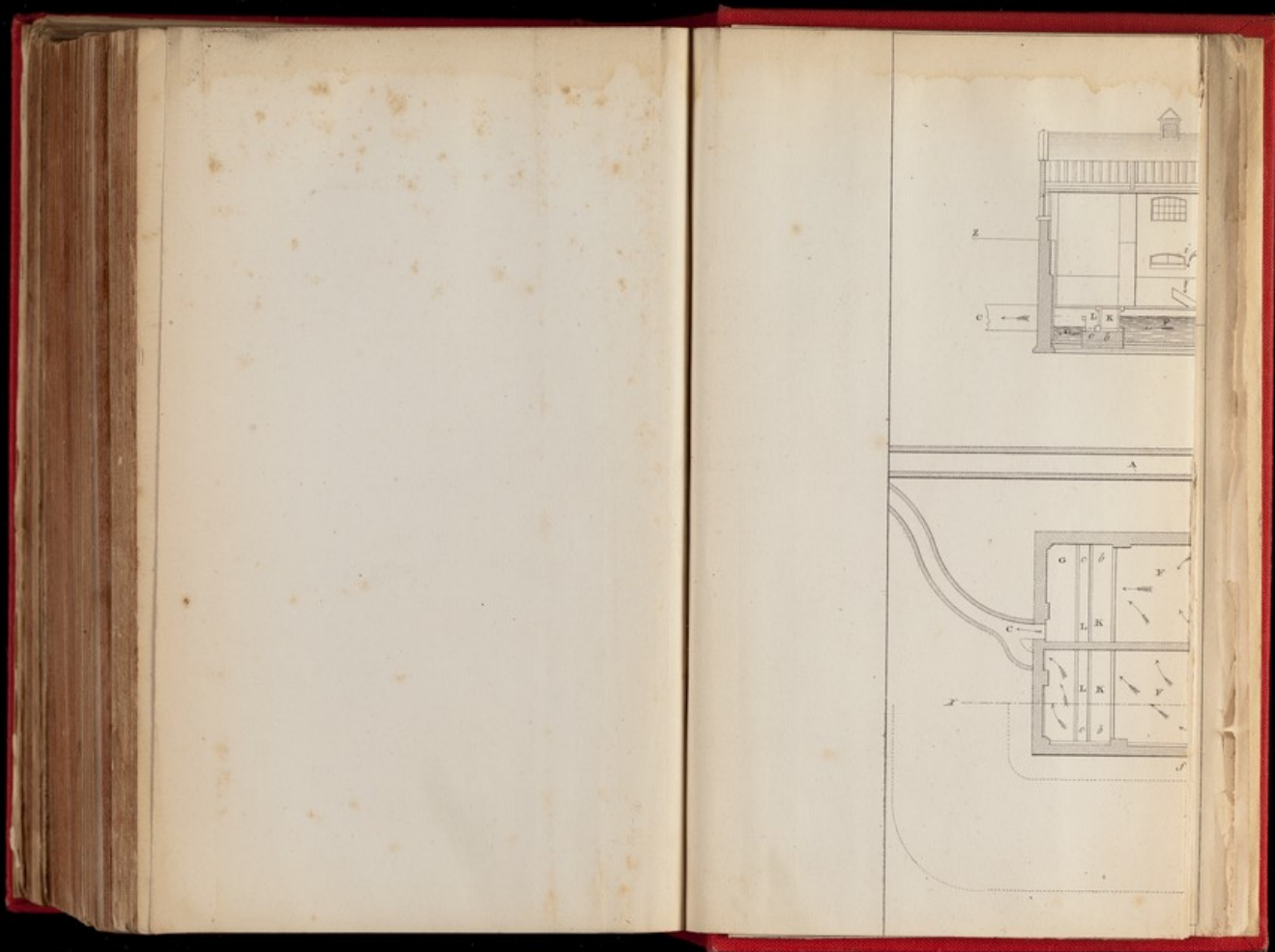
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USINE DE CHELTENHAM. (GLOUCESTER.)

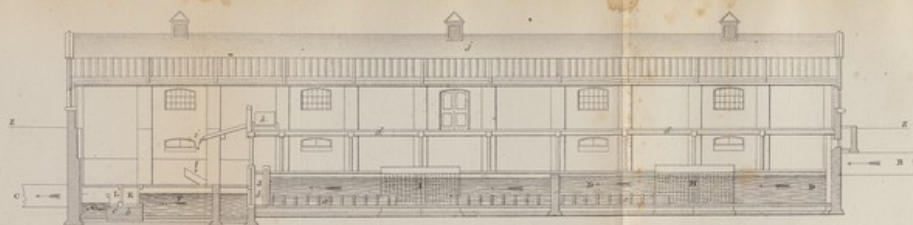


Fig. 2. Coupe longitudinale suivant XX, fig. 1.



Fig. 3. Coupe transversale suivant YY, fig. 1.

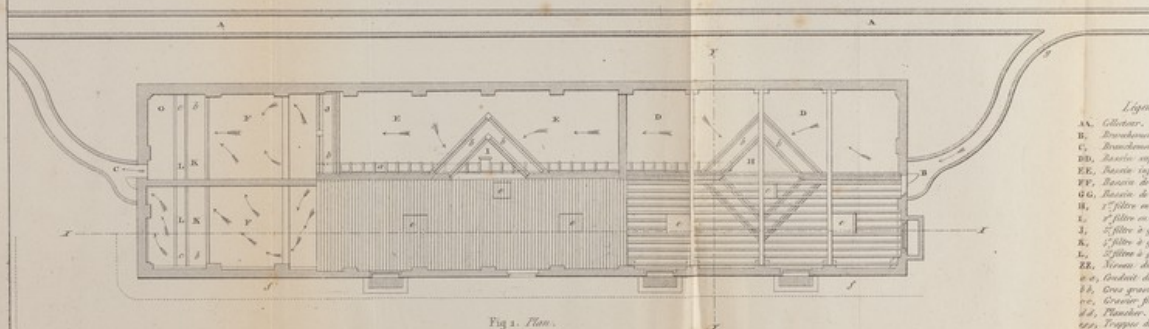


Fig. 1. Plan.

- Légende.
- AA. Collecteur.
 - B. Branchement à l'entrée.
 - C. Branchement à la sortie.
 - DD. Bassin supérieur.
 - EE. Bassin inférieur.
 - FF. Bassin de filtration.
 - GG. Bassin de dépôt.
 - H. 1^{er} filtre en planches percées de 1/2".
 - I. 2^e filtre en planches de 1/2".
 - J. 3^e filtre à gros grain.
 - K. 4^e filtre à gros grain.
 - L. 5^e filtre à gros grain.
 - MM. Vannes de sel.
 - NN. Conducts de 12".
 - OO. Gros grain.
 - PP. Gros grain.
 - QQ. Plancher.
 - RR. Trappe dans le plancher.
 - SS. Chemin de paille.
 - TT. Tanne d'industrial.
 - U. Vaggon à lait de chaux.
 - V. Diverses des Vaggon.
 - W. Tonneau en bois.

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 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320
 2321 2322 2323 2324 2325 2326 2327 2

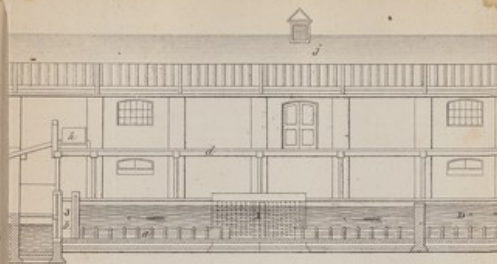


Fig. 2. Coupe longitudinale suivant L-L, fig. 1.

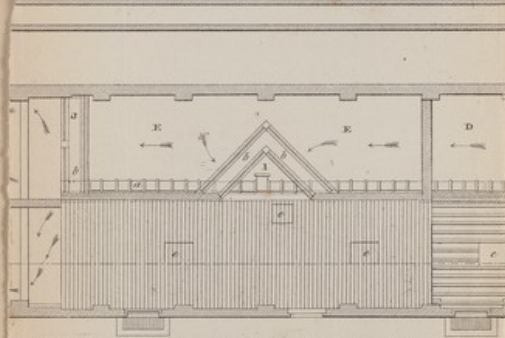
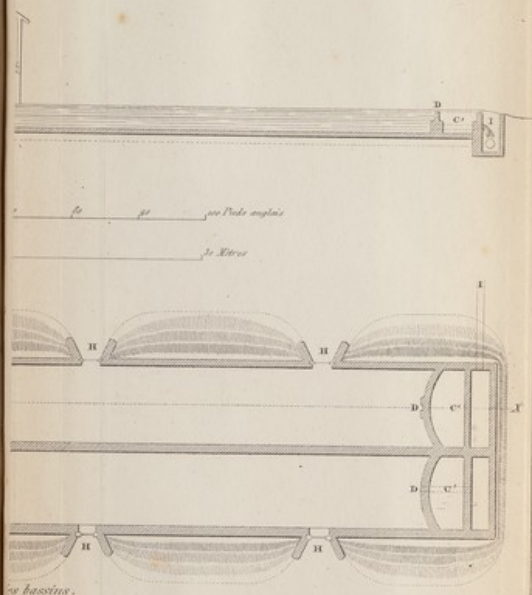


Fig. 1. Plan.

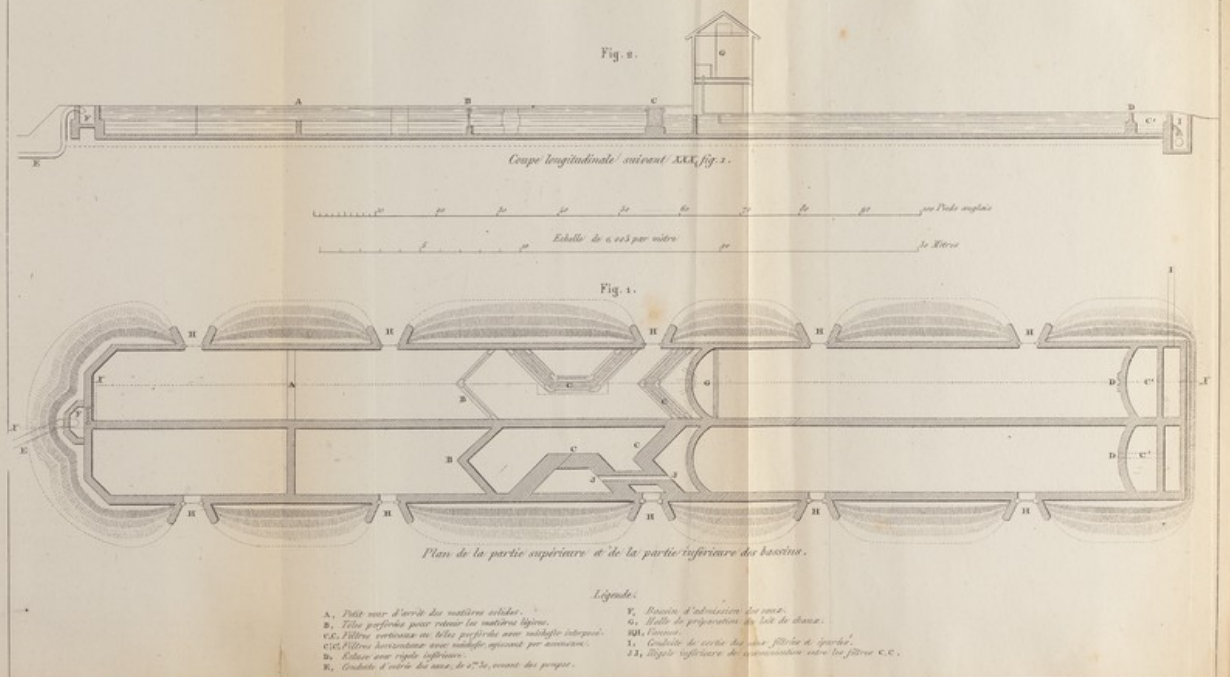
Échelle de 0,005 m



de bassins.

les eaux.
de l'air de chaux.
dans les filtres à épaves.
et dans les filtres c.c.

USINE DE CHELMSFORD. (ESSEX)



2. Coupe sur XY, fig. 1.

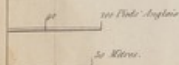


Y

Plan.

Légende.

- a. Colluvium.
- b. Sables au mélange désagréable.
- c. Planches du séchoir.
- d. Filles mobile.
- e. Filles fixes par accumulation.
- f. Regard.
- g. Emissaires.



USINE D'ELY. (CAMBRIDGE).

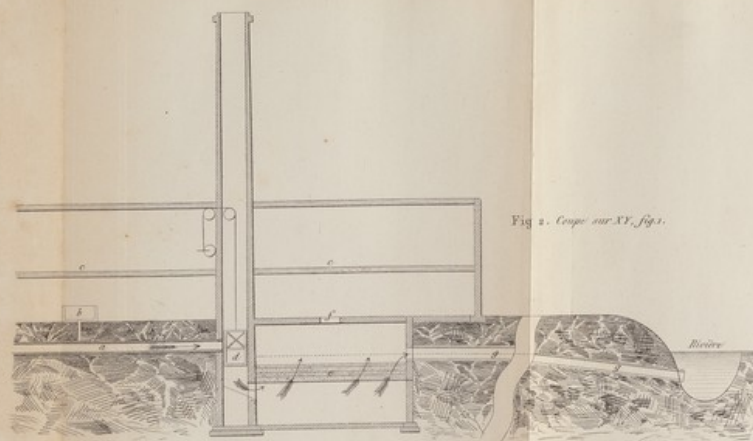


Fig. 2. Coupe sur XY, fig. 1.

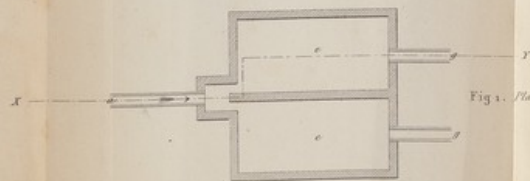
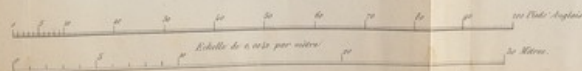


Fig. 1. Plan.

Légende.

- a. Collecteur.
- b. Filtré au mélange désinfectant.
- c. Plancher de bois.
- d. Filtré mobile.
- e. Filtré fixe par accumulation.
- f. Regard.
- gg. Évacuation.



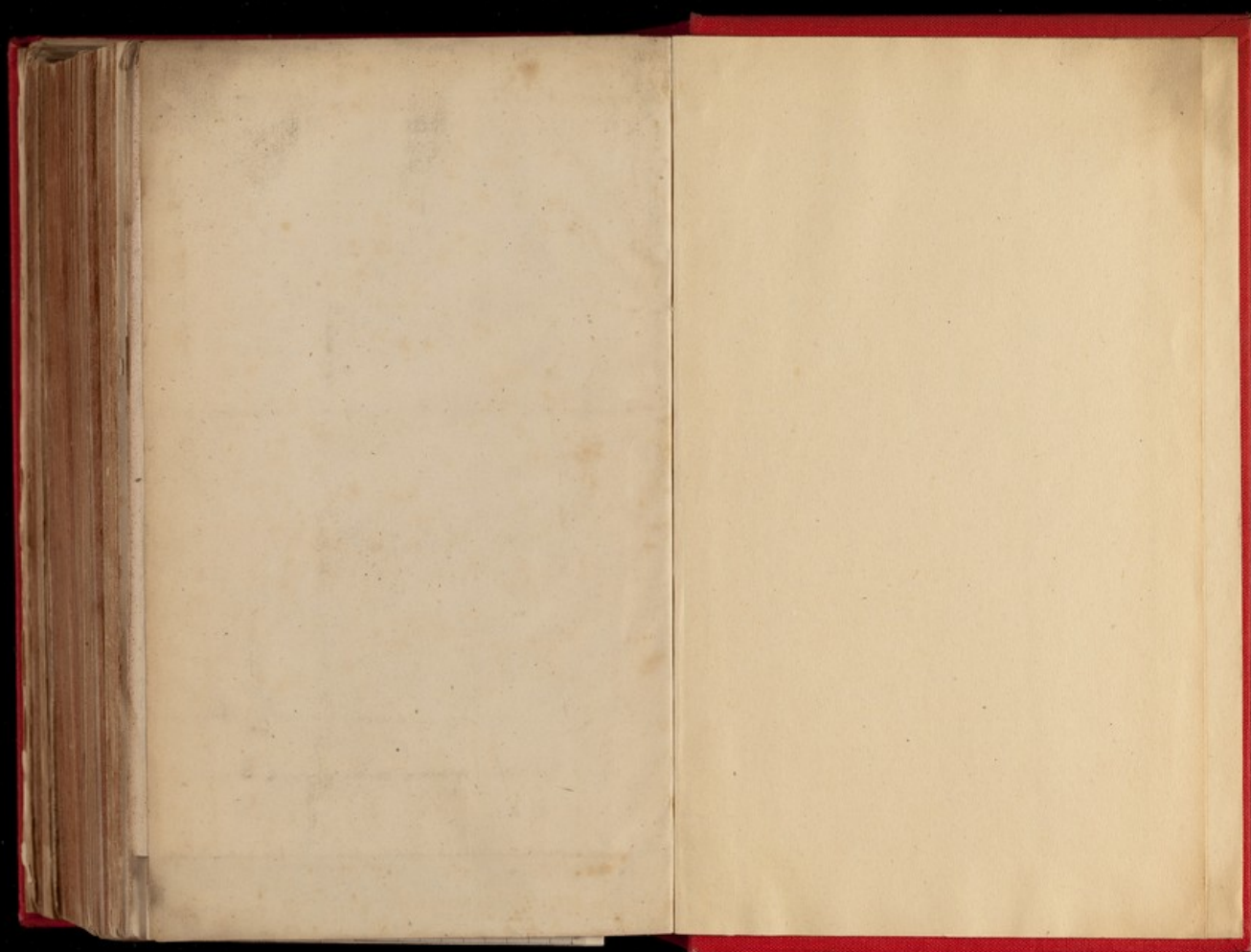


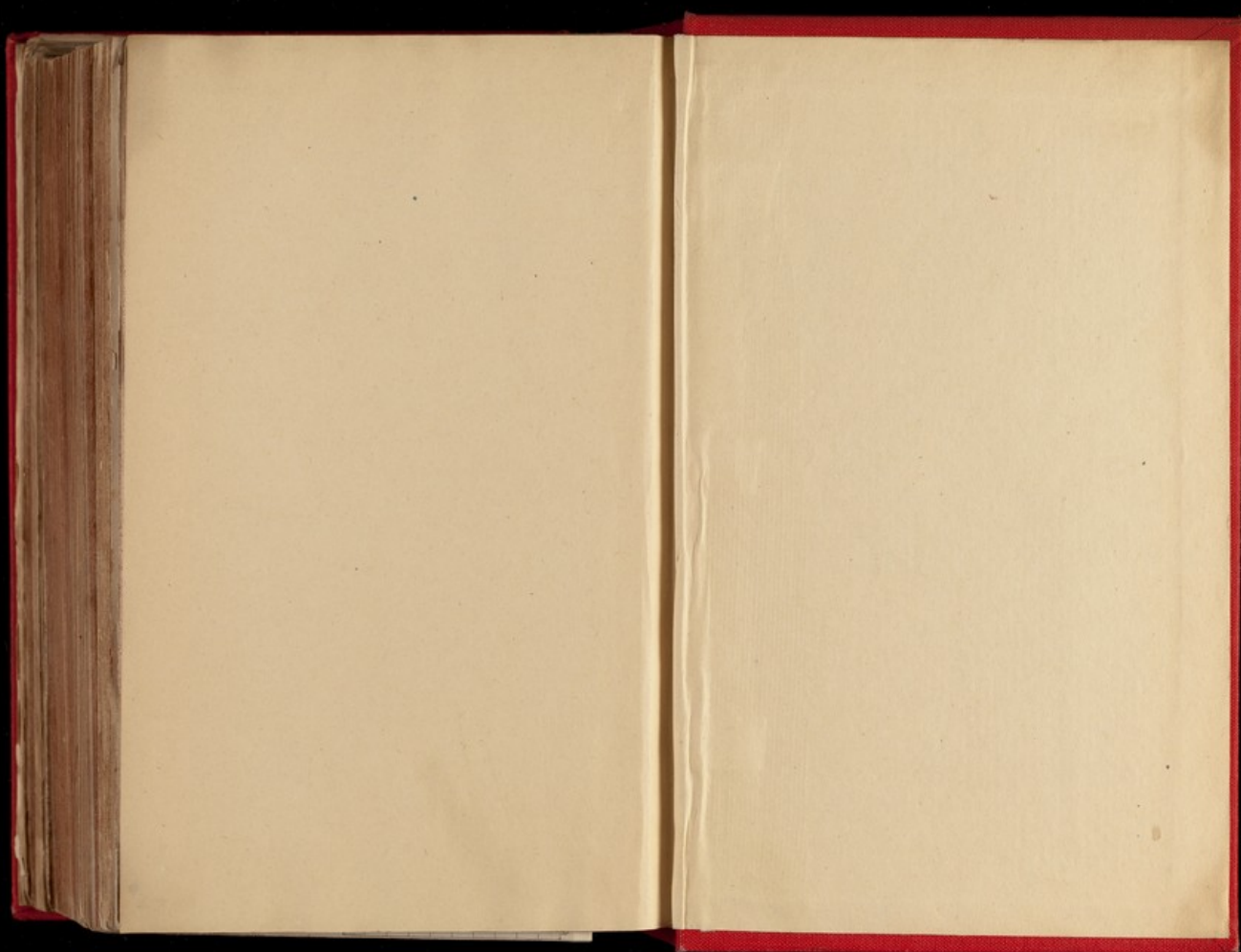
PROJET
DE LA C^{OP} METROPOLITAIN SEWAGE ET ESSEX RECLAMATION. (1865.)
APPROUVÉ ET AUTORISÉ
par le conseil métropolitain et le Parlement.

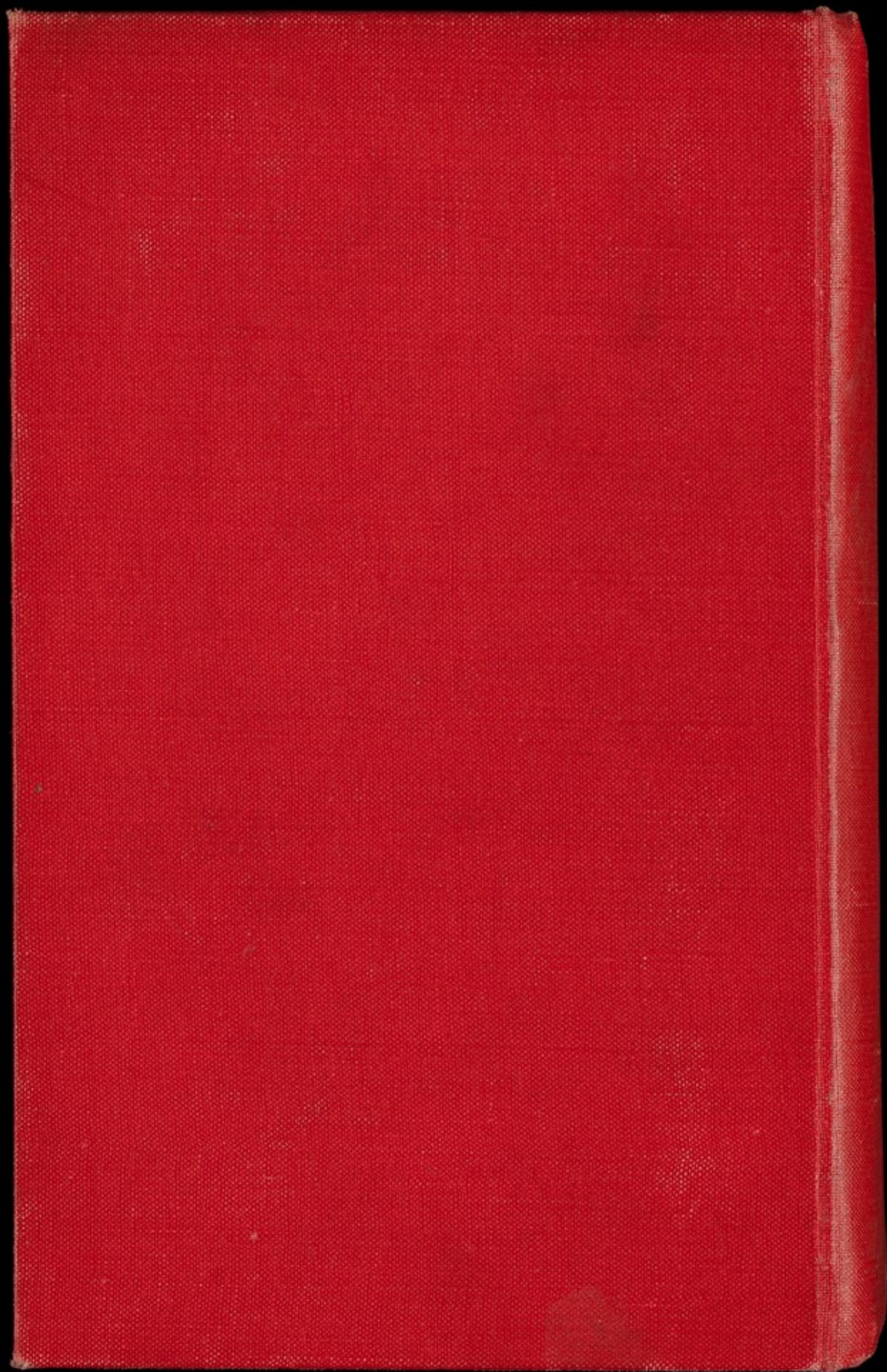
-  Surface accessible par gravitation
sans dépense de 10,000 livres.
-  Surface accessible par gravitation
sans dépense de 10,000 acres.
-  Surface accessible par gravitation
sans dépense de 10,000 acres.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100









PAMPHLETS

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