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GOVERNMENT.

READ AT OXFORD, BEFORE A

MEETING OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS,

FEB. 18, 1876,

BY

DR. ACLAND, F.R.S.

REGIUS PROFESSOR OF MEDICINE IN OXFORD;
PRESIDENT OF THE MEDICAL COUNCIL OF THE UNITED KINGDOM.

OXFORD and LONDON:
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THE RELATION OF MODERN ENGINEERING TO PUBLIC HEALTH AND LOCAL GOVERNMENT.

THERE is no chapter in human history more interesting and instructive than that which tells of the progress of the Art and Science of Engineering. When that whole history is hereafter written, it is not rash to say that, British engineers will stand out pre-eminent. Though Indian work may rival theirs in beauty, Italian in grace, Egyptian in solidity, Roman in municipal service, they will in the combination of their qualities be found to have been equalled by none. And yet, how short is the period in which British workmen have earned this fame. Some still living can remember when the lighthouse on the Eddystone was a novelty. I travelled, as a boy, on the first steam-worked passenger railway shortly after Huskisson's death. Many now living saw the first telegraph wire stretched along the Western line. Steam applied to the largest men-of-war is but a recent affair. Ironclads were begun only the other day. A full appreciation, by the masses, of Sanitary Engineering, even if it exist now, is not of five years' duration. Three years ago, a well-known speaker thought on a public occasion to gain a cheer by seeking to cast ridicule on those who prefer, like you, to prevent preventable disease, rather than only to cope with it unprevented. A like course would not be attempted now. Considering, then, the infancy of knowledge and of public opinion on this matter, it is not strange that the place of the Sanitary Engineer is not yet precisely defined.

In the Public Health Act of 1875, the summary of all health enactments, the name of Engineer does not once occur in the 343 clauses. He is still the old "Surveyor" we all remember, the plodding, energetic man of highways and byways, whose Anglo-Saxon vigour broke forth from the garb of corduroy, from the measuring-tape and links, into the transcendent skill of Macadam; and whose followers take rank with men of courage, and knowledge, and power, such as Brindley, Smeaton, Rennie, and Stephenson.

In considering the Consolidated Public Health Act, it is strange to see how the higher place of an Engineer is, by implication, conceded to him. Every urban authority may be "Surveyor of Highways," § 144; shall appoint "a fit and proper person to be Surveyor," § 189; and, "the same person may be Surveyor and Inspector of Nuisances," § 192. But then, the Surveyor of the present day may be called to advise on anything, from the form and cost of an earthen syphon-trap, to the calculation for work to be done by engines, which are to supply half-a-million of persons with water, safe to be sipped in wine-glasses, and delivered in quantities adequate to cleanse the foulest and largest of factories; to be responsible for the construction of sanitary mechanisms, from a housemaid's sink to an "intermittent downward filtration" farm. If required to

act also as Inspector of Nuisances, he is to have knowledge of what is dangerous to the public weal in respect of any and all nuisances; of all filth-producing agencies; of soundness and unsoundness of food; of occasions of epidemics and contagions. He is to be able to carry out all measures for prevention of infectious diseases advised by the medical authority: he is faithfully to observe and execute all lawful orders of the Local Government Board which may be hereafter issued.

Such is the modern Civil Engineer, when attached, for purposes of local government, to a sanitary authority, urban or rural.

I should not presume to speak on so wide a topic, but that my attention has been drawn to it from boyhood. While still a student at the University, I was much impressed by examining the gigantic arrangements for supplying ancient Rome with water, and by traversing along its whole length the splendid Aqueduct on the north coast of Africa, which, taking its rise on the hills of Zagouhan, supplied a vast stream to Udina and to Carthage. I venture to shew you various sketches illustrating this great work, made on the spot nearly forty years ago. Your attention should be drawn to the sketch in which the source of the stream in the side of the mount is shewn. It is remarkable that round this a spacious and solid edifice was raised, shewing with what religious care the source of the water-supply was protected from contamination. Not long after, during a residence of some weeks in Holland, the skill and engineering triumphs of that strange and noble country filled me with admiration. Chance fixed me in a Professorship here, and I was forced by the Local Acts to be officially a Street Commissioner. What a contrast was then found by me to those works which had so instructed me in Rome, Carthage, and Holland. An undrained town in a sodden valley; a foul and filthy water-supply; and no power to obtain money to remove these evils. Still worse, there was an administrative Board unfit and unable to cope with the evil, or appreciate the risk. It would be a strange tale for those who think we are not improving, if the complacency were described with which men then lived on a site, which, we now know, needed but a chance combination to decimate it with typhoid. The town was riddled with cesspools, in the midst of which the shallow wells were dug. The Water-works pumped up, with an uncertain and infirm water-wheel, a liquid fouled by the overhanging privies and the filthy ditches of the slums of the city. There was no systematic drainage. What drains there were, were rudely executed in gaping brick. By a special engineering effort, a sewer was constructed from the north to the south of the town. When completed, it flowed the wrong way, and was abandoned. I forbear to describe the cesspools under kitchens and in entrance halls; the alleys, the houses. An upper floor in one dwelling served as a fancy dog-kennel, which I saw filtering its filth through the rotten floor on to the bed of a woman in labour in the room below. The tenement belonged to an elected, not an official, Street Commissioner. At length the Local Acts were abolished; the Imperial Acts

were adopted; a Local Board was formed; and Mr. White has shewn you the outcome in our Drainage-works to-day.

Steadily, if slowly, the Local Board is doing its work. Every year the number of those increases in the district who have mastered the sanitary problem to be worked out in this country. We have as the assiduous Chairman of our Drainage Committee one of the first scholars of the age, Dean Liddell. Many now know well that the Regulation of the surrounding flood-waters; the purification of the Thames and the Cherwell; the distribution of the sewage by irrigation; the destruction of bad courts and of cesspools; the erection of proper dwellings; all, in short, of the requirements of a healthy town, are to be steadily aimed at, and at the earliest moment secured. Yet progress cannot be always rapid. One of the wealthiest Colleges, the chief landowner of the best building-sites of the town, has felt itself compelled to allow the erection of whole rows of villas without sewers or safe water-supply. It has thereby riddled the before virgin gravel with cesspools and wells, as in the arrangements of old; and left some unhappy householders to awake from their dream of possessing perfect modern dwellings, and to find various maladies occurring, from the combination of bad workmanship with imperfect drainage. An important public functionary also laid out rows of dwellings for the poor in all but undrainable meadows.

These circumstances are alluded to because they are an illustration of what goes on in many places, and are therefore of general interest. For we must not conceal from ourselves that the complete sanitary administration of a densely peopled state is fraught with much difficulty. Look once more at Oxford, as an illustration. It was pointed out twenty years ago that the management of every river basin as a whole is essential for the several towns on its banks. Though many riparian owners on the Thames have done much, and are spending much, Father Thames still goes his own way. He is still fouled by his neighbours; he still floods them in revenge; he still wastes his waters at his will. Would this have been tolerated in Holland, even two centuries ago? Are we to have over Dutch Engineers, as once in the days of Vermuyden, to confine him again to his banks? Will Mr. White's costly works keep the cellars of St. Ebbe's and St. Thomas's dry, or will they still leave the floods to permeate the subsoil of the lower parts of the town?

We may answer to this, that there is every hope that the Duke of Marlborough's Commission will bring to practical effect the work on which it has been now long engaged. The rate about to be levied for the Survey and other expences, will inaugurate a complete system of water regulation in the Thames valley. At all events, English engineers are ready, when they return from their Dutch engagements, to undertake our minor work here.

These circumstances, connected with the place in which you meet, have only been introduced to illustrate the subject before us:—"The Relation

of Modern Engineering to Public Health and to Local Government."

In the case of all towns, such as those comprised in the Thames valley, there is, over and above the ordinary work of town management—such as laying out streets, erecting houses on healthy models, and constructing sewers—both the draining of the surrounding districts, and securing an uncontaminated and ample water supply.

A memorial was drawn up in 1862[a], urging the Government to attend to the *Regulation* of the waters of the Thames—not to the *purification* only, but to the storeage at one time, and the liberation at the other, as afterwards recommended by the Commission of 1869. This cannot be effected without a united superintendence for the area of the whole valley. The plans of one Superintending Engineer must be followed through the whole basin, in the tributaries, as in the main channels. These plans could not be carried out without competent, well-trained local Sub-Engineers, acting under the Local Sanitary Authorities, and in harmony with each other.

The superintendence of wisely-devised sanitary areas for engineering purposes should be like the organization of one of our best railways, viz., into districts, or sub-districts, with connected supervision of the whole.

There are, therefore, many points to which the attention of an Association of Sanitary Engineers may be usefully drawn: a few may be named.

[a] See Note II., p. 22; and compare Resolutions 23 to 26 of second Report of Royal Sanitary Commission, p. 176.

An Association may help to impress on the public the detailed, as well as the comprehensive character of Sanitary Engineering, which has at length become a special and important profession, and bids fair to rival in magnitude, though we hope not in cost, the development of Railway Engineering thirty or forty years ago.

On the *details* of sanitary work it would be impertinent for me to enlarge. Yet, speaking as one of the public, I may remark that a very short time since, architects and surveyors often undertook sanitary works with very imperfect knowledge of what had been done, or of the skilled contrivances which existed. This Association will do good service, by interchanging and making public the details of their experience. Many useful contrivances, such as those made years ago by Clark of Carlisle, and many of the fittings introduced by Jennings, existed long before they were generally used. We spent much money here on bad fittings years after good ones were in the market. But this stage has passed, and we have another danger ahead—the danger of advertised and spurious wares, "floated" under many names, and processes which have not a shadow of scientific foundation. Various will suggest themselves to your minds. This is the more to be regretted, because no profession affords so many instances of valuable contrivances, either the propoundings of untaught men of genius, or the result of scientific culture by true experts. I will name three: the arrangement for dividing overflow water by the property of its velocity—applied, as I understand, first by Bateman in the Manchester Water-works[b]; the method of laying sewers in straight lines from man-hole to man-hole—a plan, I believe, devised by Rawlinson (whose name I cannot mention without esteem as well as respect); and the scraper for internally honeycombed iron pipes, invented by William Froude[c], the outcome of consummate knowledge and masterly powers of observation.

When we see great results produced by such simple methods, we do not despair of the sanitary arrangements in houses and cities becoming very shortly reduced to an absolute certainty, when every district has its Superintending Sanitary Engineer, versed in the best knowledge of the time, and a staff of conscientious workmen, such as our modern works are already educating.

The details are almost all known. That sanitary pioneer, Chadwick, has lately summarized the wants of the house to be weather-tight, damp-proof, miasma-proof, with warm fresh air, unwaste, fuel warming apparatus, safe water-supply and sewerage, *within*; and an Authority to remove refuse, and dispose of it with economy and safety, *without*. And so in the case of large collections of houses, i.e. Cities, Mr. Rawlinson has, in his masterly way, sketched Suggestions for Main-sewerage and Water-supply, on the principles which

[b] See the notice in the useful work of Baldwin Latham, "On Sanitary Engineering," 1874; or in "Description of Manchester Water-works, by I. F. Bateman, F.R.S., 1866."

[c] Report of British Association, 1869, p. 210. The scraper travelled successfully from the edge of Dartmoor to Torquay, being heard at its work the whole way.

most skilled borough engineers now apply. Gigantic works, indeed, are in operation or progress in every direction. Above all, the good sense and determination of the country is heartily embarked in the work.

Every place has its sanitary Authority, composed for the most part of elected residents—would they were always selected also; and every place, the Metropolis excepted, has but one Authority. We have entirely passed out of the stage of needing proof of the evil of insanitary conditions. We are in the hands of the Executive. We have to find out the cheapest form of permanent staff to carry out the instructions which accumulated Biological knowledge and experience demand. The Medical department of the Local Government Board will always have that knowledge. It is a knowledge only to be obtained by skilled experts, giving their lives to its acquisition. Like most other knowledge, when obtained, it may be handed on in a clear and intelligible form to all willing learners[d]. The advising Inspectors, and our highly instructed periodical literature, are making all such sound knowledge common property, possessed by the most intelligent persons in even remote districts.

Next, with respect to the comprehensive character of Sanitary Engineering. The Royal Sanitary

[d] See the Instructions for Medical Officers of Health by the General Board of Health, 1848; and the same of the Local Government Board, 1874; and those to Inspectors of Nuisances, and many local acts and bye-laws. See also Note I., p. 18, as to functions of Local Government Board.

Commission urged, and urged with effect, that there must be a Sanitary Authority for every spot, and but one Authority. This now is law. But it further advised that the Areas of the authorities should be re-adjusted. This is partially done, though it might have been better done. Medical officers can be appointed to areas of any size whatever, according to the conditions of the localities, and with the approval of the Central Board.

These two principles—the having even every hamlet under proper sanitary care; and the power of combining areas into the most suitable dimensions, according to the population, and the physical conditions of the districts—lie at the root of the whole question of national sanitary arrangements.

But we may see at a glance that these principles touch not only the details of local taxation and administration, but the mode of imperial supervision of any national funds given in aid of local sanitary work.

It is greatly to be regretted that popular writers do not always note this. They often blame Government for not settling by a stroke of the pen what touches every local interest and property in the country. So large a question has unavoidably baffled, as yet, every statesman who has approached the subject; but every Session of Parliament throws light upon it, and brings us nearer to a solution. For my own part, I retain the conviction of many years, that the true policy for securing the national health, lies in the steady education of the people, to take a thorough and intelligent interest in perfecting, under local management and central or imperial advice and supervision, their local sanitary arrangements*. I am more convinced than ever, that coercion, even if attempted, will in the end retard progress. Theorists may dislike the political truth, that in this country neither the Government, nor the people, separately from each other, direct public opinion, or make public law: it is discussion, and action and re-action, between the two, which bring about among us stable progress. Practical life in England does not rest on logical science.

The profession of Engineering is one which above all others has been self-made, without the trammels of regulations. This has been at once a source of strength on the practical side, and of danger on the scientific. But without pursuing that subject, it must be admitted that the sanitary engineers of the future will need as much consideration in a perfect sanitary organization, as the legal or the medical department. It will be for the engineering profession itself to see to the training of its students, the due supply of its ranks, and the guarantee for the fitness of its members.

The public grievously need some guarantee. Health authorities have often been put in difficulty to know in whom they can place their trust, whether they seek for knowledge to guide them, or high character to keep down expenditure.

History has shewn that much bad work has been heretofore done, either from lack of training or want of experience. Much money, too, has been

* See Note I., p. 18, as to functions of Local Government Board.

squandered, because the interest of the employer has not always been the first object in the execution of works. There are many remarks worthy of attention on this subject in the writings and autobiography of Sir John Rennie. But, this being said, it is right to add, that probably there never was a time when it was as easy as now to obtain competent and upright men for the superintendence of sanitary work.

It will go far to reconcile England to a thorough redistribution of areas for purposes of Local Government, and the establishment of a complete executive for the objects of preventive medicine, if the people are convinced that no works are advised which are not really needed, and that none are taken in hand which are not faithfully executed in respect of durable workmanship, and carefully controlled in respect of cost.

For this end, as in other departments, but two things are necessary: the average knowledge and good sense of the practical men of a district for all local purposes, with highly-skilled imperial inspectors occasionally to advise and assist. The germs of this system we already have, in both the medical and engineering departments. A few years more, and we may hope to see the full harvest of our experience gathered in, and a thickly-peopled country for the first time parcelled out into areas, where all that can be done for health is done, and nothing done which is needless or fantastic.

Lastly, in a memorandum in the Report of the Royal Sanitary Commission, the "National or Chief

Health Office," or the "Local Government Board," is said to be divided into six departments:—

1. Legal.	4. Poor-Relief.
2. Engineering.	5. Medical.
3. Statistical.	6. Medical Legislation.

In the Public Health Act of 1875, by far the greater number of clauses are necessarily devoted to subjects purely legal. Comparatively few are needed for the direction of the constituted Authorities in respect of the Medical Officer of Health, or of the Engineering Officer of Health. Every Authority is obliged to appoint both, as well as an Inspector of Nuisances; but either of the two chief officers may act in the last capacity also.

The Engineering Officer or Surveyor has a very onerous duty. He has to execute and maintain what the science of medicine suggests as desirable to be attempted, to enforce and maintain cleanliness, and to provide pure air, pure water, dry and pure dwellings. All this is to be done, as far as the conditions of our climate and nation permit, for every site in the city; from the crowded alley to the palace; for every cottage on the hill-side, and for the princely, but often dangerous, dwelling, an English country-seat.

There is a great future for the Sanitary Engineer in this country. The Institution of Engineers proudly boasts, that it aims at "directing the great sources of powers in nature for the use and convenience of man." Well have the British engineers striven to this end. They have invented count-

less machines for useful and countless ends[f]; have constructed all over the world railways and bridges, opening up unknown and before unattainable regions; have built light-houses, and docks, and ships, with scarce a rival; and lastly, they have begun a yet more useful work, more necessary, more blessed, soon we hope to be one more gem in their professional crown,—they have entered on the search after the most economical means for providing a healthy home for every man, rich or poor, according to his wants, his place, and his condition; and thus, hand in hand with the longed-for progress of education, morality, and culture, they will make possible a virtuous and happy fire-side for crowded and toiling millions.

[f] See the Preface to the first volume of Smiles' "British Engineers," a book which those who are inclined to despair of England had better read.

NOTES.

I.

THE following Extracts from the Memorandum printed in the Report of the Royal Sanitary Commission, tending to illustrate some of the functions of the Central Office, may not be out of place here. They are found in full also in "National Health," by Dr. Acland, (James Parker and Co., London, 1871, Second Edition):—

§ 1. The duties of the medical officers of public health must necessarily be considered in connexion with several complex questions of central and of local administration.

The Commission has unanimously come to the conclusion that every question affecting public health should be brought into relation with one central office, presided over by a minister. Every health officer would thus stand directly or indirectly in official relation to such a minister.

§ 2. It has been further decided that every district, urban, suburban, or rural, should, in respect of its public health, be as closely connected with the said department of health as is every part of the country with the Home Office through the police and the magistrates, and as are the destitute with the Poor-Law Board through the guardians of the district in which they are resident.

In short, that every person shall henceforward be entitled to such reasonable public protection in respect of his health as he is in respect of his liberty and his property. For instance, he shall no more be liable to have the water of his well poisoned by the neglect of his neighbour, than to be robbed with impunity.

And he is to be under this protection, as far as it is reasonably attainable, everywhere and at all times.

The *first* principle, therefore, of sanitary administration is that no member of the community shall wilfully or for profit damage another man's supply of the three absolute essentials of life, food, water, and air; and therefore that it is the duty of the State to secure, as far as possible, that these essentials shall be supplied, in sufficient quantity, and the greatest attainable purity, in all circumstances in which these objects cannot be attained by individual care and resources. In this point of view it may appear a question whether the State should allow that any man, even by prescription, shall be held to have acquired the right

to pollute, for his own advantage, another man's food, water, or air, or in any manner poison him. At any rate, care should be taken that no one shall acquire such right in future.

The *second* requirement of sanitary administration is universality, through constant supervision by public health officers in every part of the country.

The efficiency of the agents in sanitary administration is as important as their ubiquity.

They must be well-instructed and capable, without the pedantry or officiousness of sciolists. Ignorance, pretentiousness, or over-meddling on the part of the agents would bring into disrepute any sanitary system. In a free country disrepute would bring about failure. Fitness in the agents is the *third* requisite in sanitary legislation.

Though an all-pervading system of sanitary experts be thus necessary for a densely-peopled community, living in artificial or non-natural conditions singularly unfavourable to health, yet the very exigencies of such a community make it unlikely that in this country any costly system of sanitary inspection can be established at present; any proposed system must therefore be economical. Though at present the State must spend great sums on experimental armaments and weapons of destruction, it may hesitate to make costly experiments for the prevention of possible or contingent sources of ill-health. Those who are strong doubt the necessity, those who are sick—happily the minority—have not power sufficient to promote great schemes. Economy is therefore the *fourth* essential principle of Sanitary Administration. . . . .

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It must be remembered that the inspectors who will be responsible for local sanitary administration have collectively, if not individually, to administer Acts* bearing on the following subjects:—

§ 10. 1. Plans bearing on sanitary engineering or on local government, i.e. drainage, sewerage, water supply, baths and washhouses, nuisances, offensive trades, smoke, public places of recreation, streets and roads, buildings, cellars, and lodgings, burial-grounds, mortuaries, appointment of officers, artisans' dwellings, labourers' dwellings.

* See Glen on Public Health and Local Government Laws, and Baker on Laws relating to Public Health.

2. Care of personal health and safety, i.e. health in factories and workshops, mines, bake-houses, dangerous occupations.
3. Regulation of quality of food, i.e. adulterations, markets, diseased cattle, slaughter-houses.
4. Medical, i.e. prevention of disease, epidemics, endemics, syphilitic disease, small-pox (vaccination), quarantine, lunacy, hospitals [b], whether, first, rate supported, such as workhouse hospitals, or hospitals under local boards; or secondly, voluntary, whether general or special, endowed or subscriptional, county or small village hospitals, or hospitals for the insane, and prisons, sale and adulteration of drugs, poisons, supervision of reports of officers of health.
5. To which must be added medico-legal arbitrations. . . . .

* * * * * *

There should be—

I. A Minister of Health and Local Government.

II. Six (Five, 1876) permanent departments under the Minister, for—

a. Law of local government.
b. Engineering.
c. Registration and statistics.
d. Relief of poor.
e. Medical care of public health and poor.
f. Legislation bearing on the profession of medicine [c].

III. A body of inspectors attached to the Health Office. These are to be of two kinds, as at present, with a third body of consulting experts.

1st. General inspectors attached to, and generally residing in the "registration divisions," "poor-law districts," or (as they will also be) "public health areas."

2nd. Special inspectors, viz. legal, engineering, scientific, and medical.

3rd. Special experts whose names should be attached to the Office, and who should advise professionally on special points for special fees, such persons to be appointed for five years and re-eligible.

4th. There will be required local clerks of unions, and of town

[b] The whole question of the grounds of admission into rate-supported hospitals must be reconsidered by the Legislature. In Ireland the best results have ensued from the admission on payment of any persons suffering from fevers or severe accidents.

[c] This should remain with the Privy Council.—(H. A., 1876.)

councils, local surveyors under local boards and unions, local public health (medical) officers of local boards, unions, parishes, subordinate executive officers. . . .

All reports bearing on public health will be connected one with the other, mutually illustrating each other. They will cover the whole ground of the science of prevention of disease, which has become both so important and serious for the well-being of old and densely-peopled countries. The connection of the office of the Minister of Health with the medical profession, 4,000 members of which would be in direct relation to him, would in itself be beneficial to the whole country. It would disseminate established scientific knowledge uniformly through the country districts, affecting not the medical man only, but the clergy and the schools, doing in that way alone as much at least as direct legislation for the same purpose could do. It would bring to light in every corner all that could be advanced as bearing on the physical condition of the masses of the people, while all crude theories or impracticable plans would instantly fade before the experience of the Central Office.

The publications of the statistical department would exhibit what could be shewn of the progress of sickness. They might give also useful deductions from local meteorological and scientific observations, in connection with those of Kew, the Government Meteorological Office, the Meteorological Society of Scotland, and other sources. . . . .

Great encouragement should be given to local public health officers to send in any observations which would promote the progress of accurate knowledge.

The British Public Health Reports thus constructed, printed in an uniform 8vo. form, stitched in a plain distinctive wrapper, and issued in five parts, (legal, statistical, engineering, medical (including medico-legal), and general papers of inspectors,) would be a series of great value. The Central Office should immediately on the first issue of the collected series, make arrangement for regular interchange with all foreign countries of similar reports, according to the established usages of academies. These documents should be accessible for reference in the public health library of the minister to all persons connected with the department.

Public Health laboratories should be maintained or aided by grants from time to time. In them not only points bearing on the general pathology of man and animals, would be from time to time investigated under the best guidance, but persons would be trained to be thoroughly qualified in all medico-legal questions. Hereby some of the scandal of ex-parte scientific witnesses might be checked or removed. Such laboratories should be aided or maintained as well in the metropolis as in some of the great towns where scientific institutions and medical schools exist, e.g. Oxford, Cambridge, Birmingham, Leeds, Newcastle, Bristol. These centres are conveniently situated for various sections of the kingdom . . . .

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Doubt has sometimes been expressed whether the ordinary medical practitioner is sufficiently instructed in preventive medicine. Such doubt would soon prove unfounded, if the organisation we propose were adopted. The medical officers under the Poor-Law are perfectly able to fill up returns, make reports when called upon, point out cause of ill-health, and superintend such remedies as the central authority may suggest or direct. No ordinary medical officers should be expected to discharge the duties of the police, the lawyer, or the engineer. . . . .

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II.

Memorial concerning the Regulation and Purification of the Thames Waters.

1. *Whereas* the Area of the Thames and its Tributaries may be computed to contain 6,000 square miles, and extends over parts of the several Counties of Essex, Kent, Middlesex, Surrey, Hants, Berks, Wilts, Oxon, Bucks, Herts, Warwick, Northampton, and Bedford,

2. *Whereas* it is highly expedient to regulate the waters brought down by the River Thames, so that they shall be as fit for use and as little contaminated as may be, both in the district immediately above London and in the neighbourhood of all towns on its banks,

3. *Whereas* no systematic provision has as yet been made either for regulating the several branches of the waters in the Thames Basin on a common plan, or for deterring the Towns on the several parts of it from casting their sewage into the streams; and *whereas* many Towns situated above the Metropolis, viz., Richmond, Staines, Windsor, Maidenhead, Henley, Reading, and Oxford do so cast in the whole or parts of their sewage,

4. *Whereas* it is admitted that besides the injurious pollution of the waters, waste accrues from the loss of sewage,

5. *Whereas* the unregulated action of floods inflicts damage on many lands adjoining the River, and is injurious to the Health of the District,

6. *Whereas* it is certain that these evils would be greatly abated, and the Public Health improved by a more complete and systematized management of outfalls, dams, and sewers than is at present possible,

7. *Whereas* also a Report on the Thames Basin with reference to these several particulars would establish principles applicable to other River systems, and besides improving the water supply of the Metropolis, would yield much information bearing upon the Public Health, and of service to the Nation at large, and may properly be therefore esteemed a National object,

THE UNDERSIGNED solicit the GOVERNMENT to issue a COMMISSION OF INQUIRY, or to cause full inquiry to be made in such way as they may see fit, into the condition of the Thames and its Tributaries (the immediate district of the Metropolis being excepted from such inquiry, as already under special jurisdiction); to INQUIRE what defects exist; and to REPORT what remedies can be applied to such defects; having regard generally to all purposes by which the River and its branches, or lands adjoining to them, may be improved; but specially to the purification of the Thames waters for the use of the Metropolis and of the Towns in the Thames district, as well as the amendment of the Health of the Population which adjoins them.

(*Signed*)

EDWARD SABINE,	President of the Royal Society.
RODERICK MURCHISON,	Director-General of the Geological Survey.
RICHARD OWEN.	
C. B. ADDERLEY.	
WILLIAM HEATHCOTE, M.P.	
GEORGE GRAHAM,	Registrar-General.
WILLIAM FARR,	Somerset House.
THOMAS WATSON,	President of the Royal College of Physicians.
NEIL ARNOTT, M.D.	
WILLIAM A. GUY,	King's College.
R. DUNDAS THOMSON, F.R.S.,	Health Officer, Marylebone District.
JAMES CLARK.	
ROBERT RAWLINSON, C.E.,	Local Government Office.
STRZELECKI.	
CARNARVON.	
S. OXON.	
J. RANDALL,	Archdeacon of BERKS.

FRANCIS JEUNE,		Vice-Chancellor of OXFORD.
HENRY G. LIDDELL,		Dean of Ch. Ch.
HENRY W. ACLAND,		Regius Professor of Medicine.
JOHN PHILLIPS,		Professor of Geology.
B. C. BRODIE,		Professor of Chemistry.

And others.

May 28, 1862.

The invaluable Reports of the last fifteen years from the several Committees and Commissions, on Sewerage, Pollution of Rivers, the River Thames, and Water-supply, more than justify every clause of this Memorial.

Printed by James Parker and Co., Crown Yard, Oxford.

Library Army Medl. Department
from the Author

(Reprinted from the 'British and Foreign Medico-Chirurgical Review,' Jan., 1875.)

On the Physical Requirements of the Soldier.

By A. Leith Adams, M.B., F.R.S., Surgeon-Major Army Medical Department.

The following data referring to the physique of the soldier were for the most part collected during three years' official inspection of recruits in the largest depôt in the United Kingdom.

The points I have sought to demonstrate and the objects I have aimed at elucidating must be allowed to be of vast importance to the army surgeon, seeing that of late years many vexed questions have arisen with reference to the physical capabilities of recruits.

Put in the form of a question, the subjects of inquiry resolve themselves into the following:

What are the proper standards of height, weight, and chest capacity, at the various ages at which boys and recruits are eligible for military service?

Although by way of comparison I have attempted to correlate the military with the civil population, it must be understood that the figures relating to the former have no pretence to be considered in any way as referring to the extremes or averages of the population generally. They are purely of a medico-military character, having been selected by me from a heterogeneous assemblage of persons who offered themselves for military service. The data are therefore furnished with the intention of demonstrating what requirements of height, weight, and chest capacity appear to me good exponents, not only of the age of the soldier on enlistment, but also with reference to what he might be expected to attain to at manhood.

From the following table several important deductions may be drawn in connection with the four physical requirements—age, height, weight, and chest girth. These I shall now proceed to consider from a medico-military point of view.

I. Age.

In armies maintained by a voluntary system of enlistment, and more especially should there be a dearth of recruits of matured years, it will always be the case that, as the supplies decrease, the greater will be the risks of trenching on physical inefficiency.

If, as in the British army, the ages are embraced between eighteen and twenty-five, we will be sure to find a very large percentage of lads of seventeen asserting that they are eighteen or over, and men

Table showing the relative height, weight, and chest circumference at various ages.

Sources of information and numbers inspected.	Age.	Height.			Weight.			Chest girth over the scapulæ.			Chest girth below scapulæ after deep inspiration.			Chest girth below scapulæ after deep expiration.			Difference between inspiration and expiration.		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
		in.	in.	in.	lbs.	lbs.	lbs.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
London Recruiting District (37)[1]	14 to 15	61	52	55·7	96	65	77·5	31	26	27·8	31·5	27	28·8	29	25	23·5	4	1	2·6
Royal Military Asylum, Chelsea (771)[2]	14 to 15	64	49	55·5	115·5	49	73·9	30·5	23·5	27									
Gymnasium, Oxford, Maclaren (25)	14	66·4	56	61·4	125	81	98·4	33	27	28·4									
Some boys after one year's training (25)	15	69·5	57·5	63·5	132	82	106·5	36½	27·7	31·4									
Harrison's Tables (197)	14 to 15	63	48	55	...	...	...	32	21	26·5									
London Recruiting District (28)	17 to 18	69	63·5	66	143	115	126·3	36	33	34·5	36	32·5	34	32	20	29·6	4	2	2·9
Harrison's Tables (151)	17 to 18	67	51	60·7	...	...	...	34	23	27·5									
London Recruiting District (109)	18 to 19	71	64·5	66·3	152	118	135·3	38	33·5	36	38	33	36·3	36	30	32·4	4·5	1·5	2·3
Danson's Tables (100 and upwards)	18 to 19	71	58·5	64·34[3]	153	90	122·79												
London Recruiting District (80)	19 to 20	72·5	64·5	67·1	170	116	135·3	38	33	35·4	38	30	35	35	30	32·4	4·5	1	2·8
Danson's Tables (100 and upwards)	19 to 20	71·5	59	64·94	176	102	130·11												
London Recruiting District (49)	20 to 21	72	64·4	67·6	180	123	143·4	40	34	35·1	39·5	33	36·5	36	31	33·4	45	1·5	2·7
Danson's Tables (100 and upwards)	20 to 21	71	61	65·11	176	111	135·58												
London Recruiting District (47)	21 to 22	72	64·5	67·4	180	125	144·5	41	34	36·2	39·5	34	36·4	37	31	33·4	5	1·5	2·9
Danson's Tables (100 and upwards)	21 to 22	71·4	60·5	65·57	168	101	131·02												

London Recruiting District (25) .	22 to 23	71	65	67·7	160	130	144·6	39	34·5	36·1	39	34·5	36·8	36[4]	32·1	33·6	3·5	1	2·4
Danson's Tables (100 and upwards)	22 to 23	73	60·4	66·17	184	98	138·41												
London Recruiting District (17) .	23 to 24	72·7	65·5	67·6	182	119	141·2	39	34	35·9	38	34	36	36·5	30	32·9	4	1·5	3
Danson's Tables (100 and upwards)	23 to 24	73	59	66·17	180	110	142·95												
London Recruiting District (23) .	24 to 25	72·5	65	67·3	199	122	144·9	40	35	36·1	39	34	36·2	36	31·5	33·7	4·5	1	2·4
Danson's Tables (100 and upwards)	24 to 25	73	57	65·9	180	110	142												
London Recruiting District (9) .	25 to 30	69	65·5	67·1	188	124	141	40	34	36·1	41	34	36·2	38	32	33·5	3·5	2	2·7
Danson's Tables (100 and upwards)	25 to 30	72	59	66·30	190	114	145·65												

[1] The data here are exclusive of the measurements of the Chelsea boys, who go through the London Recruiting Office before entering the army.

[2] Thus, since 1860, of all the boys admitted into the asylum the tallest at fourteen years of age was 64 in. in height and weighed 115¼ lbs.; the shortest being only 49 in. in height, and weight 49 lbs.

[3] Quetelet, in his work 'Sur l'Homme,' makes the average height in Belgium at this age 1·658 mètres, or 5 ft. 5·27 in. According to the data furnished by him, growth is nearly completed at eighteen, as he gives only an inch afterwards, an assertion not maintainable as regards our race; and although the average here given by Dawson is probably below, it may be accepted that ordinarily two inches are added to the height after seventeen in men whose stature is sixty-seven or sixty-eight inches at thirty.

[4] The average age of the recruits for the City of London Police Force, one of the most magnificent body of men to be seen in any service, is twenty-two and a half years. Of 300 recruits for the year 1872 I am informed by the surgeon, Mr. Childs, that the average height is 5 ft. 9 in. and chest girth 37½ in.

of thirty to even forty ready to swear that they are under twenty-five years of age.

The difficulty in arriving at anything like a correct judgment is far greater at the lowest limit. It would be less so at seventeen, for the difference between sixteen and seventeen as regards physique is generally more easily determined than between the latter and eighteen; besides, provided seventeen was made the minimum military age, certain requirements as to height and weight might (as will be suggested presently in the case of boys) be demanded as a safeguard.

The grand point for the surgeon to consider at the maximum limit is whether or not there are the promises of sufficient stamina in the man for the shortest period for which he could be enlisted, without the risks of his breaking down or becoming a burden to the service. For instance, many men to all appearance thirty years of age show indubitable promises of at least twelve years' good work. The only drawback to these recruits, particularly in the case of navvies and agricultural labourers, is that they lack the activity and aptness of younger men, although they rival them in strength and "staying power."

Of course careful selection is necessary at both extremes of age. Thus, especial selection of men from the present maximum limit up to thirty might be made with seeming advantage, at all events for short periods of service.

Boys.

Boys are enlisted as musicians, drummers, buglers, or tailors, between fourteen and sixteen years of age. No physical requirements are demanded, as in the Navy, so that there is no rule to guide the military authorities; neither are birth certificates furnished, as in the former and in the case of the boys of the Royal Military Schools at Chelsea and Dublin. In the London district alone, during the last three years ending December, 1873, no less than 500 were passed into the service from various charity schools and the Goliath training ship.

The object, of course, in public charities of every sort is to get rid of the boys whenever they arrive at the eligible age. But seeing that no register of birth is preserved, it is left to the authorities to estimate the probable age of the lad, so that he may be furnished with an occupation as soon as possible. Again, very many of the boys have lost one or both parents, whilst all more or less partake of the physical aspect of the town-bred lad. Their aptitude for music and tailoring being the military requirements, any intelligent, puny, and consequently not unfrequently precocious child who displays a turn one way or the other is selected for the army, whilst the larger boys take to rougher occupations, and are readily sought after by tradesmen as apprentices and so forth. From the above it is evident that none but well-developed lads of the average height and weight, of boys of fourteen years of age, should be taken; and even allowing for the diversities in these respects of lads in their teens, it will be conceded, in the case of the charity schools of London and other large cities, that a standard of physical requirements might be established with advantage.

The lowest limits in the navy is fifteen years, unless in special instances, where boys between fourteen and a half and fifteen are received provided they are 56½ inches in height and not less than 27½ inches round the chest.

Referring to the table—

I. I am indebted to Mr. Crosse, of the Royal Military Asylum, Chelsea, for the data shown as to the boys under his care. It must be stated, as regards height and chest girth, that these boys had been drilled and trained, many for seven years; moreover, being born of one parent of military stature is in their favour with reference to the latter.

II. The calculations Mr. Maclaren has been good enough to permit me to publish were taken from young gentlemen who attended the Oxford gymnasium. As compared with the other admeasurements in the table, they very much exceed any data to which I have had access, but nothing beyond what might be expected of lads who had been carefully reared from infancy. The measurements are further suggestive as showing the marvellous effects of well-directed gymnastic exercises on youths, and how much such would benefit boys enlisted at fourteen, who are not at present amenable to a course of athletic training.

III. Harrison's tables[1] were formed haphazard from the data furnished by factory children in a crowded city, and include both sexes, hence the chest girth is valueless beyond the age of fourteen years.

IV. It must be fully understood that the boys examined by me were selected from a large collection of the usual run of lads brought up for inspection. The same to some extent obtains with the soldiers' sons at the Royal Asylums.

Some idea of the inefficiency represented in the case of the former may be gathered from the circumstance that, out of 673 boys brought before me from charity schools, no less than 167 were found unfit on account of muscular tenuity and stunted growth, and even of the number accepted not a few appeared to be one or two years younger than stated. The military surgeon is therefore helpless in such cases, unless he establishes standards of height, weight, and chest girth. These, of course, will vary in individual

[1] 'Edinburgh Medical and Surgical Journal,' 1835, p. 425.

cases; still, within certain limits, it is clear that a well-nourished promising boy of fourteen years of age should be 4 feet 7 inches in height, weight 74 pounds, and chest girth 27 inches, or by the infra-scapular method to be detailed presently the maximum girth expansion should be 28 to 29 inches, and the girth after an expiration 26 to 27 inches. This I found to be the only safe way of dealing with the heterogeneous collections of London boys in particular.

The military method of taking the chest circumferences as in older persons is extremely fallacious and unreliable for exact medical or other evidence. Healthy boys whose ages are determinable might be safely accepted an inch to two inches under the above height, but in such cases the weight ought not to be under 73 pounds.

Although the boy age extends to sixteen, very few are obtained over fourteen, for the reason that the latter is the limit of maintenance at the various schools from whence boys are furnished. I have consequently been unable to obtain data in connection with boys between fifteen and sixteen years age.

"Eligible lads between seventeen and eighteen years of age."[1]

Under special circumstances, very promising lads of seventeen and short of eighteen can be enlisted on the certificate of the examining surgeon that they "are in all respects fit for the service." The latter virtually means that they are very promising lads: to perform the ordinary duties of a soldier, in peace or war, being impossible at this tender age. At all events, whenever anything like hard work is imposed, the advantage has always (as may be supposed) been with older men.

In the table I have correlated what appears to me the maximum and minimum measurements of eligible lads between seventeen and eighteen; and taking into consideration what are designated "race characters"—in other words, that the Anglo-Saxon is physically not of the shorter Celtic stature—these data appear to me fair exponents of what we should expect at seventeen years of age. Of course there are qualifying exceptions, but in view of future requirements I think military youths should show a minimum height of 5 feet 5 inches, weight 120 pounds, a chest girth over the shoulder-blades of 34 inches, and a maximum expansion and minimum contraction of the chest of 33 and 30 to 31 inches.

It is noteworthy that the scapulæ project more in flat-chested and rapidly growing lads than in matured men, hence they increase the girth to a deceitful extent; indeed, a comparison of the two

[1] See General Order, No. 95, November 1st, 1872.

methods in the table shows how valueless is the supra-scapular admeasurement as an index of thoracic capacity.

The averages shown in the table, viz. height 66 inches, weight 126 pounds, chest girth over shoulder-blade 34½ inches, with a chest expansion of 34, and a minimum chest contraction of 31 to 32, were obtained from 28 youths especially selected as good representatives of the age under consideration. These selected youths, compared with the 151 factory boys and girls taken from the general population, give remarkable contrasts. As to chest, as just observed, no reliance is to be placed on Mr. Harrison's measurements for obvious sexual reasons.

Between eighteen and nineteen years of age.

This being the minimum recruiting age for the able-bodied soldier, great deception is practised. Taking the numbers of men who do not know their ages exactly, and the greater portion who purposely make misstatements, there is very frequently nothing left to the surgeon and the military officer but the exercise of their own judgments in determining whether or not the youth is capable of bearing arms.

If the lad's assertion is invariably accepted, and the military authorities adhere strictly to the letter of the law regarding requirements of height and chest girth, whilst the surgeon merely pronounces on the soundness of his health, then there may be no end to the admission into the service of young and feeble youths and men of poor physique. The above age, like the preceding, being only that of the promising youth, demands simply an advance on the physique, but such an improvement over seventeen that, looking towards twenty, it is necessary to exact certain data in relation to height, weight, and chest, and these must be considered with reference to the demands of different arms of the service. Thus, the 60th Regiment Rifle Brigade and artillery drivers take youths of this age as low as 5 ft. 4½ in. in height, whilst tall powerful men are wanted for gunners and heavy cavalry; again, the light dragoon and lancer, and finally the linesman and engineer, all of whom demand from the nature of their work the possession of excellent stamina. It has, however, been the case of late years that the infantry service has failed to attract so many able-bodied men as formerly, whilst the cavalry ordinarily continue to receive supplies of much the same quality as heretofore.

I. The *beau idéal* of an active skirmisher will be found assuredly among the short dapper men of the two regiments with dark uniform —"cobby little fellows," as a colonel of one of these rifle corps expressed himself when giving directions to my coadjutor Colonel Lyons regarding recruits for his battalion. All other points being

equal, that is, taking into consideration the set appearance of the lad of eighteen, I would expect him at that age to stand not under 5 ft. 3½ in. in height, weight 126 lbs., chest over scapulæ 35 in., greatest expansion 34 in., and minimum contraction 32 in. The great danger of introducing inefficiency at this age with the above height, or even 5 ft. 4½ in., will arise from want of attention to the general physical characters which experience has shown are adaptable to the work of the small-sized rifleman and driver of artillery; indeed, this caution is applicable to all ages and to all branches of combatants. At headquarters of corps it is looked to, but at recruiting districts it has been the habit to stick too much to regulation as regards height and chest girth, not taking probable or real age in any ways into account. This, considered medically, is a serious physiological error, to which I will again revert in the sequel.

II. The second taller type of man for the general infantry service should at eighteen years of age give a minimum height of 5 ft. 5. in., weight from 125 to 130 lbs., and chest girth over scapulæ of 34 in., and a maximum expansion of 34½ in., and a minimum of about 31½ to 32 in. Danson's tables are valuable as far as they extend, but only the height and weight are given. The records were taken from 4800 British male criminals, and the averages were derived from 100 observations and upwards at each age.[1] According to this authority the mean height was 64·3 in. and weight 122·79 lbs., which are not far below what I have advanced for the soldier at this age. Dr. Aitken,[2] arguing from Danson's statistics and other data, gives an average height of 63·003 inches to the lad of eighteen years of age, a figure which, however applicable to the general mass of the population, would be sure to produce evil results if acted on as a standard of military stature in the Anglo-Saxon.

There is no especial object in continuing comparisons or furnishing data beyond nineteen up to twenty-five years of age, as, provided the requirements of youths up to the former are clearly realised, there can be no difficulty in adjudicating the standard afterwards. In fact, the whole difficulty is to be assured that the promising lads of seventeen and eighteen carry sufficient physical characters so as to ensure that they will turn out to be able-bodied men of 67 in. in height at twenty-five years of age. Nothing, of course, is more variable than the rate of growth; it may, however, be accepted that a well-nourished healthy lad, who at manhood should attain to the above height, will have to make at least two inches between eighteen and twenty-five. Very little is added after twenty, whilst the majority of lads make the greatest strides in height between fourteen and that age. Thus, I have always been of opinion that the recruit of

[1] The difficulty in being certain of the age of the inmate of a gaol must, if anything, be rather greater than in the case of the recruit.

[2] 'Science and Practice of Medicine,' vol. ii, p. 216.

64½ to 65 in. at twenty is not likely to add even an inch subsequently to his height; in fact, the 60th Rifles and Rifle Brigade and artillery drivers, in order to maintain uniformity of their low stature, should be recruited by men not under twenty years of age.

The statistics of the armies and peoples of Europe furnish instructive illustrations of diversities in stature. Thus, Pouchet[1] asserts that the inhabitants of the south of France are demonstrably shorter than Frenchmen of the northern departments. This statement is further shown to have some intrinsic value, whether as "a race character" or a sign of "deterioration of race," by the rejection of no less than 10 per cent. per 1000 of conscripts examined between 1836 and 1840. Moreover, Danson shows in his excellent paper referred to that the French army from 1835 to 1843 gave a common average of height of 65½ in. There is one thing always to be borne in mind with reference to the physique of the French soldier, viz. that since the beginning of the century there has been a terrible drain on the population for warlike purposes. It must, therefore, be a matter for speculation how much any decrease is owing to the baneful results of wholesale conscriptions carried on for years or to inherited race characters, or both. No doubt the ancient Celt was of small stature as compared with the Teuton and Anglo-Saxon of the present day, but since those times there has been such an intermixture of races that to attempt mathematical accuracy would be useless.

Published data in connection with the Austrian conscription of 1870 shows that of men of the classes of 1848, 1849, and 1850, no less than 141 per 1000 were rejected as being under the minimum height standard of 61·19 in., and 565 for medical reasons. The differences in stature between conscripts raised in the northern and southern commands are remarkable. Thus, the stature of the former varied from 5 ft. 4 in. to a little over 5 ft. 5 in., with an average chest girth (taken between the respiratory acts) between 32 and a little over 33 in. Poles, moreover, were still shorter, the height varying from 63·256 to 64·25 in., whilst the Croats averaged 65·4 in., and the Dalmatians, the tallest of all, gave an average between 66·4 and 67·7 in.[2]

It is well known that men at any given age attain the same average height and weight as older or younger men; consequently, regarded from a military standpoint, our great aim should be to discriminate as closely as possible all varieties of stature and weight at the uncertain ages between seventeen and nineteen, seeing that beyond the latter there is never any difficulty in estimating what the man should be.

The extension of the army age to thirty would bring a certain

[1] 'Plurality of Races,' p. 47.

[2] I am indebted to my friend Captain Cooke, Statistical Department, War Office for these figures.

increase, but selection would be specially necessitated, and the recruit could only be engaged for short service, so that, including the reserve service, he would be forty-two years of age on his discharge from the latter. In order to give scope for selection the limits of age, therefore, might be seventeen and thirty.

II. Height.

Standard requirements.

According to existing regulations, the following are the physical requirements of the various branches of the service, showing the chest girth to height.

	Age.	Chest to Height.
Infantry .	18 to 25	in. 33 fr. ft. in. 5 5 to ft. 5 in. 8 : in. 34 fr. ft. 5 in. 8 to ft. 5 in. 10 : in. 35 fr. ft. 5 in. 10 and upw.
60th Regiment Rifle Brigade .	18 „ 25	34 „ 5 4½ „ 5 7
Drivers R.A. .	19 „ 25	35 „ 5 4½ „ 5 6½
Gunners R.A. .	18 „ 25	33 „ 5 7 „ 5 8 : 34 „ 5 8 „ 5 10 : 35 „ 5 10 „
Heavy Cavalry .	18 „ 25	34 „ 5 8 „ 5 10 : 35 „ 5 10 „ 5 11
Medium ditto .	18 „ 25	34 „ 5 7 „ 5 9
Hussar & Lancer	18 „ 25	33 „ 5 6 „ 5 8 : 34 „ 5 8 „ 5 10 : 35 „ 5 10 „

One of the most noteworthy particulars in the above is the lowest chest girth required for infantry, gunners, and cavalry, between eighteen and twenty-five years of age, and between 5 ft. 5 in. and 5 ft. 8 in. Thus, a circumference of 33 in. chest at twenty-five years of age in a man 5 ft. 8 in. in height represents a very slight frame. Again, a man of the latter height and eighteen years of age must be looked on with grave suspicion as to his future physical capabilities; both conditions may be said to be beyond the border line of natural growth, at all events in a vast majority of instances. The surgeon, indeed, who accepts these figures and merely gives the recruit what may be called a "clean bill of health," would most assuredly be lending his hand at introducing serious elements of inefficiency into the army. In fine, chest girth is only useful to the recruiter if he chooses to employ it in making choice of the volunteer, so as to save himself the trouble and expense of bringing up weeds and boys. To be even of effectual use to him the minimum chest girth should not be under 34 in. Next to height, of course, weight is the most important factor in determining the physical capabilities of the recruit, but unfortunately it is the least reliable, as will appear presently.

Lowest standard of height and ranges of age in Continental armies.

	Height.	Age.	
Sweeden . .	65·5	17—30	Mostly voluntary enlistment.
British . .	65·	18—25	Reduced to 64½ and 64 inches on urgent occasions.
German . .	63·7	20	In special cases and during urgency the standard is lowered to 61·826.
Danish . .	62·83	21	The liability to serve commences at 17, but enrolment does not take place until 20.
Austrian . .	61·19	20	
Norwegian .	61·10	22	
Belgian . .	?	19	
Italian . .	?	21	
Russian . .	?	21	
French . .	60·3	20	
Roman soldier .	62·5	...	Liability to serve began at 17.

It will be observed that the advantages as regards height are with the voluntary systems, which, again, have the disadvantage on the score of age. Thus, whatever the lad in his teens may display as compared with the shortest conscript, the latter is far more likely to withstand sudden and severe prolonged exertion, and of course, all other points being equal, he is the better suited for warfare. Again, in order to make the above figures at all useful in determining the physique of the fighting man, it is necessary to know what proportion in numbers men of the minimum standard of height bear to taller conscripts, and also the other physical requirements which should accompany them.

It would seem, however, that the lower the minimum military standard of a nation, that either the stature is naturally short or else there is a difficulty in meeting demands by taller men. Our soldiers, especially the infantry soldier, is of less stature now than formerly. Of 351 pensioners of the line at present in the Royal Hospital, Chelsea, Dr. Legertwood informs me that the average height is 5 feet 7¼ inches. These veterans, borne down by the weight of years and infirmities, and taken promiscuously from regiments, furnish a fair exponent of the soldier of a quarter of a century ago, when the minimum stature of the recruit was fixed at 5 feet 6 inches.

Of the conscriptive armies, the Germans naturally take the first place with reference to stature.

It must be borne well in mind, however, that with many short races there is a relative development of chest capacity, weight, and stamina, so that they may be as physically equal to the *ordinary*

requirements of warfare as a much larger people; nevertheless, how long an army composed of short men would withstand the impetus, if I may so use the expression, of taller and heavier men, not only physically but morally, is doubtful. In the struggle for existence among lower animals we find nature's law pretty constantly maintained; so with mankind, when short are confronted in battle with larger men, both equally bold and adventurous, the odds naturally will be against the former. But there are exceptions wherever the moral qualities are defective; thus, the stunted Ghoorka of Nepaul, a valorous mountaineer, is immeasurably superior in valour to the Hindostanee sepoy, although, physically, the latter is both much taller and stronger.

III. Weight.

For practical purposes it is unnecessary to seek a closer determination of weight than in pounds. All my observations, as in the case of height and chest girth, were taken when the man was perfectly naked. The above most important element in physique is of course the least reliable; indeed, it is more the exception than the rule to meet with an instance of a recruit being up to his highest standard of weight, and this is the case more especially among town-bred than country recruits. The reasons are obvious when we come to sift the recruit's history and the causes of enlistment in very many cases. Great allowances require, therefore, to be made for previous circumstances; at the same time it is requisite not to allow too broad a margin, without fully weighing every consideration in relation to the man's physical capacity, more especially the size of his bones and chest expansion.

The data furnished in the table represent the variations in weight of *selected* recruits at all ages. The lowest weights shown at the ages of eighteen and nineteen must invariably carry with them compensating conditions with reference to bodily development and clear indications of a promising increase; indeed, the man of 8 stone 4 pounds, or 8 stone 6 pounds, at any effective military age or height, has to add at least half a stone before he can attain to anything like the development of an able-bodied soldier, but the gain is often remarkable; however, in many instances the assurances at enlistment are poorly fulfilled afterwards, in spite of the advantages of excellent food, regular habits, and the salutary exercises of the gymnasium, and this is most generally the case with the city-bred youths, who have of late years taken the places of a vast number of countrymen. Those recruits may be active and more intelligent than the labouring man, but for campaigning purposes and ability to withstand trying climates they are clearly unsuited. Again, it is affirmed that the great revolutions in gunnery of late years seem to point more to the activity than the strength of the combatant, and there may be some truth in the assertion, although it is difficult to separate the two conditions and think of the rapid and trying marches made by the Germans during the late war, also the modern systems of drill; besides, the English of all other soldiers should be selected for endurance, at all events with reference to foreign service. We are naturally a tall race; that is, what would be called a fair stature in certain countries when applied to Englishmen would take in very many of the puny undergrowths of our densely populated cities, more especially when the standard of height is reduced to its minimum.

With reference to the boys from the Military School at Chelsea, I am informed by Mr. Crosse, that, looking to all the lads who have passed under his observation for many years, and from a mass of data, that he had estimated the average weight of a well-nourished healthy boy of fourteen years at 77 pounds to a height of 56 inches. The value of this opinion is enhanced by the circumstance that the ages of the lads were known exactly, and that they had been placed under excellent hygienic conditions for several years, therefore everything had been done to raise their physiques to their utmost capacities. These data nearly agree with the averages I have deduced from thirty-seven selected boys from civil establishments, as seen in the table. Mr. Crosse further considers that a boy between seven and eight years of age should, in order to come up to the above standard, show a weight of 44·24 pounds to a height close on 45·08 inches.

IV. Chest Circumference.

Modes of measuring the chest.

The method pursued in our army is to place a tape quite horizontally round the chest in a line with the upper part of the nipple, so as to include the shoulder-blades also. It is not to be drawn tight, and during the process the arms hang loosely, whilst the recruit counts up to ten slowly.

The inclusion of the scapulæ and large chest and back muscles render this plan barely what may be called an approximation to the real thoracic internal capacity. This is the case just as much among the spare and weakly as with the large and well developed; indeed, the shoulder-blades often protrude more in the former than in the latter. As a military requirement the chest girth was introduced of late years. Formerly, when recruits were plentiful, it was not taken into consideration, for the reason that the standard height was not so low, and selection could be made of the strong and able-bodied only; since then the physique of the recruit has decreased, and in order to prevent the acceptance of ineligible men it was deemed requisite to establish a check on the limits of inefficiency,

which, of course, increased with the dearth of supplies. As in the cases of age and height, the chest circumference is vouched for by the military authorities.

With reference to its surgical value, there is no need of remark; indeed, as far as being a criterion of the breathing power or endurance of the individual, it may *per se* be said to be of little or no value.

The posture of the arms also makes a difference. By the sides and when extended horizontally the girth is much the same, but when raised perpendicularly there is a certain increase which is more pointed in persons accustomed, such as blacksmiths, to exercise the dorsal muscles. Of course a very great deal depends on the condition of the respiratory act at the time; for example, in the Austrian army the girth is taken "during the pause between the two motions," whilst in the Prussian army it is made "after a maximum inspiration."[1]

As far as the chest girth is of value as an exponent of the breathing capacity, I have long practised the method well known, viz.—A narrow tape divided into tenth parts of inches is carried round under the inferior angles of the scapulæ and over the nipples, the recruit standing at ease with his arms stretched out slightly under the horizontal, when with his mouth closed he takes a deep inspiration.

2ndly. When the arms are dangling loosely by the sides he is desired to make a deep expiration or a prolonged whistle, so as to empty the lungs. The difference between the two acts varies a good deal in individuals, and very much depends on the intelligence of the recruit; indeed, what between a voluntary and almost instinctive disposition to keep the thorax expanded it requires great care in execution, and therefore, as a substitute for the present method, it is entirely beyond the intelligence of the recruiting sergeant.

The spirometer is also liable to give false results from want of care and inaptitude on the part of the experimenter. Its application in the recruit room would be serviceable in doubtful cases of lung disease, and of all instruments I have seen the very delicate pocket spirometer invented by M. Casela is about the most perfect. The indication, however, of sound lungs will be best tested by a faithful record of the *normal* respiration in contradistinction to a *forced* expiration.

According to the existing army regulations, a chest girth of only 33 in. at all intermediate ages from eighteen to twenty-five, and from 65 in. up to 68 in. in height, is required. Beyond the latter up to 40 in. in height an additional inch is demanded, and 35 in. of a chest circumference for any increase afterwards. However much these

[1] Dr. Körber's 'Results of the Re-examination of the Marine Recruit in the Russian Service.'

data may assist the recruiter in making choice among the very varied material among which he picks and chooses, they deserve small attention at the hands of the surgeon; at all events he will do well to be ruled in no ways by any apparent claim these considerations may be made to exact.

What might be called the "play of the chest," *i.e.* the difference between the maximum and minimum infra-scapular method just described, varies very much individually, and at all the ages from fourteen to twenty-five, but ordinarily it is between two to three inches.

It will be seen from the table that the maximum inspiration rarely exceeds the supra-scapular girth beyond an inch. Thus, by substituting the former plan for the latter in the relative requirements of age to height as laid down in recruiting regulations,[1] the chest girth would stand thus:—1. Men between eighteen and twenty-five years of age and between 65 and 68 in. in height should show a maximum of $33\frac{3}{4}$ in. and a minimum chest girth of 31 in. 2. Between 68 and 70 in. in height the two girths should stand $\frac{34\frac{1}{4}}{32\frac{1}{2}}$. 3. Over 70 in. in height, $\frac{35\frac{3}{4}}{33\frac{1}{2}}$ in.

It appears, therefore, that ordinarily there is about an inch between the girth taken during a deep inspiration as compared with that by the method at present in use in the army; much, however, depends on the care and attention bestowed on the operation.

The large experience afforded by the London recruiting district has demonstrated that the minimum chest girth of 33 in. is far more frequently incompatible than otherwise with physical efficiency as far as able-bodied soldiers are concerned, whilst by comparison it has been found to be a fair girth standard of promising lads between sixteen and seventeen years of age. Finally, with reference to age, it is very apparent that a large number of recruits of the lowest standard of height either wilfully or through ignorance exaggerate their age, so that, provided they come up to the requirements as regards stature and chest girth, no exception is ordinarily taken to the age, even when the countenance and general aspect clearly belie their oaths. Hence, instead of able-bodied men they are merely promising lads, who, if carefully trained, will probably turn out to be able-bodied soldiers in time. But the most serious results of a low physical standard is the likelihood of admitting the staminaless undergrowth of crowded cities into the ranks.

According to existing regulations, the responsibility as regards the physical efficiency of the recruit is divided between the military and medical officers who may pass him into the army. Should

[1] General Order, December, 1870.

discrepancies arise connected with the recruit's age, height, or chest girth, and the regulated standard, it is the former who becomes answerable, whilst the surgeon is accountable only for the presence of disease of a disqualifying nature. Hence, should the military requirements be of a low standard as regards physique, the medical officer may merely pronounce on the absence of disability, and thus, what between the misstatements of the recruit as regards his age and the divided responsibilities, it may easily happen that men physically unfit for the arduous duties of the British soldier would be often accepted.

The obvious remedy for the evil would be to place the entire responsibility of the physique of the soldier in the hands of the surgeon, who demonstrably is the legitimate authority, and whose judgment, matured by experience of the man and his work, should be equal to the occasion. The objections to this mode of procedure are likewise patent. According to a voluntary system of enlistment, carried out on existing principles with a vicarious supply and an ever constant demand, it might so happen that the former would not meet the latter when the surgeon finds himself the sole arbitrator of the physical requirements of the recruit. But of one point I feel assured, viz. that it is far better that an army should be composed of able-bodied men than expanded by weeds and boys.

REMARKS

ON THE

SPREAD OF LEPROSY

AT THE

CAPE OF GOOD HOPE,

BEING

AN APPENDIX TO THE REPORT OF THE SELECT COMMITTEE OF THE HOUSE OF ASSEMBLY, 1883.

BY

REV. CANON BAKER,

CAPE TOWN.

CAPE TOWN:
W. A. RICHARDS & SONS, PRINTERS, CASTLE-STREET.

1883.

REPORT

OF THE

SELECT COMMITTEE appointed by Order of the House of Assembly, dated the 25th July, 1883, to Enquire into and Report upon the SPREAD OF LEPROSY, and the best means to be taken to check the same;—Committee consisting of Dr. ATHERSTONE, and Messrs. DE SMIDT, M. J. DE VILLIERS, DU PREEZ, and T. LOUW.

Your Committee having examined witnesses and taken evidence, have to report that the result of our inquiry shows:—

1. That Leprosy prevails extensively in this Colony, and is steadily spreading amongst both white and coloured classes.

2. That no efficient steps have been taken hitherto to prevent the spread of this loathsome disease, and to avert the terrible evils which threaten society through heredity, and in other ways, from the indiscriminate intercourse and intermarriage of lepers with other classes of the community.

3. That it has been conclusively proved to your Committee that, by proper measures energetically and efficiently carried out, it is possible to arrest the further progress of the disease, and ultimately to stamp it out altogether.

4. That for the accomplishment of this object an Act for the compulsory segregation of all lepers is necessary, and the establishment of leper institutions in suitable localities where perfect isolation can be secured.

Your Committee therefore recommend, for the protection of the public and in the interests of humanity, as well as of the sufferers themselves, that the Government should, as early as possible, take steps to secure the passing of a "Compulsory Leper Act," and the commencement of a system of isolation and curative treatment.

THOS. LOUW, Chairman.

Committee Rooms, House of Assembly,
5th September, 1883.

APPENDIX A.

Remarks on Leprosy at the Cape of Good Hope, by the Rev. Canon Baker.

The time that could be given to my examination on the subject, on the 8th inst., was too short to be of much service. I therefore gladly acceded to the request to send in a condensed statement of my opinions and experience before being more minutely questioned.

Having been present during the evidence of Dr. A. Abercrombie and of Dr. Parson, I could ascertain the points on which information was sought, and the objects of the enquiry. The replies of these professional men, and the remarks of Dr. Atherstone, confirmed my own views, and gave me valuable guidance upon the subject. My own opportunities for investigation have been rather exceptional, and my advantages considerable. In early life I was a Student of Medicine, and subsequently of Chemistry and Natural Philosophy at University College, London. My appointment as Chaplain to the Lunatic Asylum and General Infirmary on Robben Island, where I remained nine years, put me in the way of getting experience among lepers, and I commenced at once, and continued to make the nature of this terrible disease a special subject of enquiry. In my present sphere of duty, I see unhappily many cases for investigation.

The chief points of enquiry are:—

1st. The spreading of the disease;
2nd. The danger of it with regard to contagion;
3rd. The causes of it;
4th. The measures to be adopted for preventing its increase, or to effect its removal;
5th. The scope of the proposed Act of the Legislature.

1st. The increased spreading of the disease in many parts of the Colony is now generally admitted, though cases are brought to light which, during former ignorance among the population, would have escaped observation. It is spreading among both the white and the coloured races, especially in places near the sea-coast. There are two causes of this, without entering on the question of contagion or infection. On the coast people eat a great quantity of fish, and an almost exclusive diet of fish does not sustain vigorous health, but predisposes to disease through the lowering of the system. The other cause is that the degraded and deteriorated classes gather where this diet is remarkably cheap. Thus many of the infected will bring the disease to the coast, and there be more likely to propagate it in their offspring. Then it must extend to the inland parts of the Colony by means of dried fish, which many of these lepers certainly assist in curing for the market.

2nd. Danger from contagion or infection.—These terms are very loosely applied, and the popular idea of contagion differs greatly from the professional [illegible] is often a question of degree and of mode.

Thus, because leprosy is not to be compared with yellow fever, as to the danger of breathing in company with the infected, people will not admit of any degree of danger, though there is no reason to believe that the less active virus of leprosy may not be inhaled, under some conditions of the lungs, and in such quantities as to cause infection. Some writers maintain this opinion. I have known two cases of fainting from the effect of the odour of this disease; one, that of a chaplain, the other of a surgeon's dresser. Though accustomed to remain about two hours, once a week, in the leper-wards, and to visit occasionally, I always took the windward side and preferred the draught of the doorway; but for fear of contagion, I invariably washed face, neck, and hands after long visits, because of the conviction that the virus might be conveyed by the many flies of the island, that rather preferred the sores and odour of the lepers. Leprosy is not to be compared with small-pox or scarlet-fever as to contagion, any more than can typhoid fever, but this can be conveyed in excreta, finding its "nidus" or seat of incubation, in one part of the body only; and so, while many will escape leprosy who handle patients, as they may handle decomposing corpses, with the skin of their hands unbroken, others may have their blood-vessels or absorbents come in fatal contact with the active poison of this disease.

The germs may be conveyed to the system with food exposed to the poison, and find in the viscera some lesion through which to enter the circulation, or find a nidus in the tissues.

The comparative power of contagion has led many investigators to error; and opinions much depend on the fashionable theories of the day. Thus, now that the "germ theory" is being made known from the investigations of Pasteur and others, the danger of contagion will rapidly find believers, who will magnify the peril. I have examined and compared many authorities. The Blue-book of the College of Physicians was supposed to settle the question in the negative; but my own conviction, after reading it carefully through, was that the evidence was about as strong on one side as on the other. The cases reported by some practitioners in India were enough to make one exceedingly cautious. Gentlemen had taken the disease from their attendants, and servants from their masters. The introduction of a lad into a household led to the disease in several of the junior members. One patient was infected by sleeping in the bed of a leper.

I must, however, say that in the Report on "Leprosy in India," by T. R. Lewis, M.B., of the British Medical Department, and D. D. Cunningham, M.B., of the Indian Medical Department, published in Calcutta, in 1877, one statement in the Blue-book was contradicted. It was affirmed that two attendants on the sick in one Leper Hospital had taken the disease. Lewis and Cunningham stated there was no foundation for this. These authors do not think there is satisfactory evidence of contagion, though they say "the reverse has been stated with regard to the history of the Asylum"—that at Almara—"though without foundation." Dr. Liveing, Physician to the Middlesex Hospital, in his Goulstonian Lectures for 1873, says, "Facts, too, are slowly accumulating which tend to prove that the casual inoculation of leprous matter is one actual means of spreading this fell complaint." The modes of conveyance may be understood from a case given by Dr. Hoegh, in his Report on Leprosy for 1855, quoted by Liveing:—

"He suggests that the ~~disease is~~ communicable through the Itch Acaris, which in Norway commonly infests the skin of lepers. He mentions a remarkable case in point, which had come under his own observation, of a family living at a farm in the Bergen district, 2,000 feet above the sea level. The eldest daughter, aged twenty-five, associated with a leprous girl of the neighbourhood, and became afflicted with the disease; a sister who slept with her, and a brother aged fifteen, both subsequently became lepers; and lastly, the mother fell a victim to it. In this case there was no history of hereditary taint, and none of the family had suffered from cold or privations of any kind, but all were severely affected with itch." Dr. Liveing states that "in South America, and some other countries, we have the strongest reason to believe that leprosy did not exist formerly among the native tribes, but that it was imported from other countries, and has now spread among the aborigines, even where no inter-marriages have taken place." He refers to the history of leprosy in the Sandwich Islands in the same manner; and in another part of his work quotes from Dr. S. Kneeland, of Boston, U.S.:—"How it is produced is a matter of question. It was not known in those Islands till 1848, at which time it was said to have been introduced by Chinese, and it was not noticeable as a disease of the country till ten years afterwards. There can be no ground for doubt that it spreads by cohabitation, and inoculation of its diseased fluids in the same way as syphilis." Dr. Liveing does not appear to have read Miss Bird's book on the Sandwich Islands, for he states that the people "are well fed," whereas the observant authoress describes their remarkable propensity to eat all kinds of fish raw, and even decomposed, some varieties of which suggest by their peculiar colours a poisonous tendency. This work by Isabella L. Bird, "The Hawaiian Archipelago," should be read by all who take an interest in this subject. In the chapter on "Leprosy and the Leper—Settlements on Molokai," she gives most valuable information. I shall have occasion further on to quote from it. Here I refer to it on the danger of contagion, and the rapid spreading of the disease:—"The natives themselves have been, and they still are, perfectly reckless about the risk of contagion, and although the family instinct among them is singularly weak, the gregarious or social instinct is singularly strong, and it has been found impossible to induce them to give up smoking the pipes, wearing the clothes, and sleeping on the mats of lepers, which three things are universally regarded by medical men as undoubted sources of infection." [*Contagion?*] "The persons horribly afflicted appeared neither to scare nor disgust their friends; and therefore Hawaai has absolutely needed the coercive segregation of these living *foci* of disease. . . . Between 1866 and April, 1874, 1,145 lepers, 560 of whom were sent from Kahiti in the spring of 1872, have arrived on Molokai, of which number 442 have died. At the present time the number on the Island is 703, including twenty-two children." Some conditions of climate, as extremes of temperature, moisture with heat, &c., favour the extension of the disease, by making persons more liable to contagion. This accounts very greatly for the discrepancies in the opinions of various writers. Professor Erasmus Wilson "expressed it as his decided opinion, that though leprosy was, under favourable circumstances, non-contagious in

Europe, it was possibly contagious in tropical and semi-tropical countries." Dr. Liveing says, "we cannot shut our eyes, to the fact that leprosy very frequently occurs in members of the same family, even when hereditary transmission is out of the question, and that Europeans not unfrequently become leprous, by residence in countries where the disease is endemic. . . . . "The problem to be solved is this: Do the physical and natural relations of the country" [he has been speaking of Cairo, New Orleans, and Rio] "alone explain these facts? If not, we are driven to the conclusion that the disease is in some way communicable from the unhealty to the healthy. For my own part, I am inclined to believe, that though leprosy is not contagious in the ordinary sense of the word, it is nevertheless propagated by the imbibition of the excretions of those affected, much in the same way (not in the same degree) as typhoid fever or cholera are propagated; but as leprosy is developed but slowly, there is far greater difficulty in tracing it home to its true source." [I have always held this view, on account of the fact that leprosy is fearfully hereditary, yet children seldom show symptoms until near the age of puberty—J.B.] Then, in a note, he continues, "What Dr. Williams, whose authority no one will question, has stated in regard of pulmonary consumption, one form of turberculous disease, is, in my opinion, equally applicable to the other cachexy:—'Although I concur in the opinion that we have no evidence that pulmonary consumption is infectious like small-pox, scarlatina, &c., *yet I think*,' &c."!

As climate makes so much difference, what is to be said with regard to it in this country? This climate, not being extreme, is not likely to intensify the malignity of the disease so as to render it remarkably contagious; but the rapid changes at times from heat to cold are believed by many to promote development of it. The main causes of it here must be looked for in the intermarriage of races, and the very familiar intercourse between them; also in the use of much *dried* fish and dried flesh, with a scarce supply of vegetables and milk. The cases of accidental inoculation must be numerous, for these patients are commonly obtrusive, and will not admit that they have the disease. Besides which, the statement of its not being strictly, in every sense, as professionally considered, a contagious disorder, has, in the ignorance of the masses, misled and disarmed the people, even the intelligent.

I have reserved the most important evidence as to contagion until the last, as it is the latest brought forward by scientific enquirers, and it confirms the continually-revived opinion that there is contagion in some manner, whatever may be the extent of danger under particular circumstances. True leprosy is a tuberculous disease, as clearly established by Dr. Abercrombie, in his Thesis, 1861. Dr. Abercrombie, since that date, has arrived at the conclusion that the disease is contagious; and he has been led to this opinion by extended observation in the Colony, doubtless under the light of recent scientific investigations. I will here, for the sake of brevity, simply quote from Professor Tindall's article on "Virchow and Evolution," in the "Nineteenth Century," November, 1878:—"Again I think Professor Virchow's position in regard to the question of *Contagium animatum*, is not altogether that of true philosophy. . . . It already appears in the 16th century. . .

He who invented the term ought, I think, to be held in esteem, 'nevertheless,' says Professor Virchow, 'no man was able throughout a long time to discover these *living germs* of disease.' 'At last,' says P. Virchow, 'in the 19th century, we have begun by little, really to find *contagia animata*' [*living germs of disease*, J.B.]. Had he said 'as long as a single *fungus* of disease remains to be discovered, it is your bounden duty to search for it,' I should cordially agree with him." Samuel Wilks, F.R.S., in "Nineteenth Century," December, 1881, speaks of "inoculation of tubercle." Pasteur's experiments have made the public acquainted with these *living germs*, as in the silkworm; and most readers know something of the Anthrax Bacillus. In the *Lancet*, July 30th, 1881, appeared a most valuable article on "rod-shaped corpuscles" [Bacilli], discovered in leprosy-tubercles, and their generating by inoculation. It says, "Evidence of considerable weight has been lately brought forward to show that leprosy must be included among the diseases which are due to parasitic organisms." "The successful cultivation of bacteria from a case of this disease, by a French Physician, was lately noted by our Paris Correspondent." "Klebs stated that groups of bacteria can readily be found in an extirpated tubercle, and that their form and arrangement are totally different from that of the organisms met with in other diseases." "The material on which Neisser has worked, was derived from 21 cases, and in every case, in all the pathological products, he found the specific form of bacillus; they occupied the interior of the large round 'leper cells' described by Virchow, either diffused through the protoplasm or aggregated into groups." "The presence of bacilli in the peripheral nerves is of special importance, since it brings together, as due to one pathological process, the tubercles and the anæsthetic symptoms which have clinically been so widely separated. They are very slender rods, their length being half or three-quarters the diameter of a blood corpuscle. They are straight or slightly curved, and resemble most nearly the bacilli found by Koch in the septicæmia of the mouse, but are rather less delicate." [I may mention a fact of some apparent correspondence in this place—that one or more mice have been seen at Robben Island, near the Leper Hospital, having tubercular lumps on the nose and ears, which made them receive the name of "leper-mice." I give this on the information of the present chaplain, the Rev. A. R. M. Wilshere, M.A. It may be that the near affinity between these two kinds of bacilli, enables the mouse to become affected, when some other animals reject the contagion. I remember a quantity of pork being returned to the contractor as unfit for food, when the same contractor stated that the pig had been purchased from the Island, where it was fed near the leper-wards.—J. B.] It is said that "animals resist inoculation" with bacillus, "though considerable importance attaches to the organisms obtained by *culture*, from the fact that the resulting forms can also be detected in the leprous tubercles." These germs sometimes are reproduced by "budding," and by fine fibres. It is important that "the organism to which this bacillus bears the closest resemblance appears to be that which is believed to be connected with ordinary malaria." [This is in favour of the opinion that want of ordinary sanitary arrangements is one great cause of the increase of this disease.] The *Lancet* continues, "In rabbits the large bacillus-holding cells quickly perish when introduced; but in one case of experiment on dogs, in the animal which died a month after the inoculation, there was found beneath the scar minute delicate new growths crammed with these bacilli; the resulting disease must be regarded as a local leprosy produced by inoculation." The mode of transmission may be conjectured from the statement that "in the juice of the tubercle, and in the pus from the resulting ulcers in which the organisms are abundant, active movements may be observed. The facts suggest that it is *essentially contagious*." The same writer inclines to the opinion that it may be also "infectious" [in some degree] "by means of its specific products; tubercle cells, tissue juice, and pus. At the same time, all the liquids, and even all the pathological secretions of a leprous patient are not specifically infectious."

That the disease spreads rapidly under favourable conditions, as in a weakly and careless race exposed to corrupt foreign influences, is evidenced by the Sandwich Islanders, for the same writer [*Lancet*] says, "In the Sandwich Islands, for instance, the disease was unknown forty years ago, and now a tenth part of the inhabitants are lepers."

Some writers deny its being hereditary; but from my reading and long experience, with the information derived from many medical friends, as Dr. Ebden, Chairman of the Medical Committee, Dr. Murray, Dr. Norbury, R.N., and others, I am enabled to express *certainty* on the subject, that it is very highly hereditary. If it were not so, other causes of increase would be more terrible than we can well imagine. For instance, in the epithelium, discovered by the microscope, left on the edge of a glass out of which any person has drunk, what danger must there be both from syphilis and leprosy! Dr. Biccard, S.S., of Robben Island, informed me of a case of contagion, that a gentleman and his son took the disease from playing on the flute of a bandmaster of a Dutch regiment who was affected. Dr. Edmunds, late S.S., found the bootmaker, Ct., apparently infected in one or two fingers, after mending boots worn by lepers; and he ordered that no more boots should be sent to be repaired. A carpenter died on the Island, in my time, whose mother said she had no doubt that he took the disease by putting the bodies of deceased lepers into their coffins. The mother herself afterwards manifested signs of the disease, which she believed to have been conveyed into her system through the washing of her son's clothing. As she was an English woman, it is improbable that there was a taint in her system before the birth of her son, who nearly reached middle age. I have subsequently heard of many cases in which contagion was believed to have been the mode of reception.

3rd. The Causes of Leprosy.—The primary cause is unknown, as with cholera. Whether or not it arises spontaneously in any locality, is questionable. But where there are germs of the disease its spreading is undoubtedly occasioned, in great part, by dirty living, unclean feeding, and loose habits, by reckless folly, and invincible ignorance. About the time of the Reformation, the disease died out in England and Ireland and other parts of Europe, owing, it is thought, to the improved diet of the people, who up to that period lived on fish and pork, and other preserved flesh, on bad bread, and

other substances that contained little nourishment, or were directly unwholesome. Exclusive fish diet is certainly dangerous, and so is abundant use of preserved fish, as potted prawns, &c. How much of this may come from the handling by patients of the articles to be exported cannot be known, but the danger is considerable.

Dr. Liveing attributes much of the disease to *bad* fish, and gives particulars which are very striking. Dr. Hutchinson speaks of decomposed milk, decomposed cheese, and decomposed pork. It is now known how liable the pig is to the horrible *trichina spiralis*, a microcosm which invades the whole system of human beings and causes horrible death. But he says, "I have, myself, arrived at the conclusion that fish is the one sole cause of leprosy." He dwells on the condition of Norway as an evidence. He speaks of India and Burmah, as fields of its effects from eating of preserved prawns, which are there extensively used. Fish soon decomposes, and *dried* fish may easily become poisonous at its surface, while preserved or potted fish may have incipient decomposition concealed by spices. I conclude that some kinds of fish at particular seasons, and all kinds decomposed, are dangerous, where leprosy is in any degree endemic. The Egyptians were large eaters of fish, and they suffered much from *leprosy*; and Mr. Hutchinson says, "The Hebrews wept over the memory of the fish they had eaten in Egypt: they acquired the habits of the Egyptians, and they acquired leprosy." A writer in *Public Opinion*, June 9, 1883, says "the cured and pickled fish, for which the Jewish merchants were celebrated, were largely exported to Greece and Rome." From the Talmud, he gathers that the Rabbis enjoined that "the curing should be perfect, otherwise the fish was deadly. In all cases a rigorous washing was ordered." . . . "In the month of Nisam such food was believed to *promote leprosy*." Some species of fish in the waters of the Cape are, at one season of the year, infested with worms.

4th. The Measures to be taken to Prevent its Increase.—Hospitals for lepers would afford facilities for obtaining better knowledge of the disease, and of the efficacy of remedies. Besides which, the sick would be removed from the healthy. Patients are believed by Liveing to be curable, if removed to places where the disease is not endemic, who would otherwise find no remedy. Therefore it would be well to shift the population of a neighbourhood in which there is found a remarkable increase of the disorder. Agriculture should be encouraged for the supply of the best food. Fish should be inspected before sale, and the curing should be under sanitary regulations. Imported and all potted fish should also be examined. The marriage of lepers should be disallowed. They should not be admitted into schools with other pupils, or mix with other people in places of public resort. At Robben Island they have a part of the church appointed for them; but, unhappily, other patients during the day occupy the same benches. Information should be diffused by every available means, as in schools, mission-stations, &c., by educational works, and by the public press. No person should act as nurse to the healthy who comes from a house in which is even one leper, even occasionally, residing. No family, in which is any leper, should have clothes washed with those of others unaffected. No person living with one affected should be allowed to wash for other people or with others.

Medical men or attendants should use precautionary measures in going from infected dwellings. It is thought that, to the fourth generation, members of a leprous family should not marry, though by continued change of blood, the disease may in time die out, notwithstanding the danger of its reappearance at any intermediate time. While our statesmen and philanthropists are seeking to develop the material resources of the country, a greater evil than pecuniary depression may be going on rapidly. Indeed the evils of endemic leprosy cannot be measured by the numbers of the *visibly* affected, for it is most difficult often to distinguish the diseased. Some do not show it in their faces, or even on their hands; they may be thought to have nothing more than an ordinary sore leg or some slight eruption. Then undoubtedly it leads to allied affections, which in another generation may return to the leprous type. One member of a family may be disfigured, while others, stronger or younger, never show symptoms, though intelligent observers, may mark some indication of the affection, if there be hereditary taint. Sad as is the thought of the sufferings of those afflicted, it is wrong to allow them to remain in ignorance, or for others to be, through their ignorance, endangered. A community must be guarded, though individuals have to suffer. Religion must afford consolation, while it shows the path of duty. The manner in which a whole community may become generally diseased, is, I think, conclusively shown in *All the Year Round*, Vol. XXI, 1878, on the "Cagots," who are believed, on good grounds, to be descended from leper ancestors. They are in the neighbourhood of the Breton Moors. They were once spread over the western seaboard of France; "there are from 2,000 to 2,500 in Berne alone." There were many leper localities in England in the middle ages; and one leper hospital of which we read was in French-street, Southampton. "There is still a strong feeling against intermarrying with them; and no wonder, says M. de Roches, for they are an unhealthy set, sitting all day over their looms in damp cottages, instead of working in the fields. In Brittany a doctor told us that there is a marked scorbutic taint in most of their families." The writer says, "the soft, damp air of Brittany has, perhaps, hindered the old mischief from wholly wearing itself out, as it has done in more favourable conditions." Some of the same quarantine regulations enforced on these people were carried out with regard to lepers in England in former days.

5th. The Scope of the proposed Act of Parliament.—To effect compulsory segregation of all lepers in the colony is impossible at present. Not only on account of the cost of institutions, but that the popular feeling would be completely against it, until the inhabitants are fully informed on the subject. In Honolulu it was found that concealment was practised in every way by the friends of the diseased. Yet much may be done at once, and much more be provided for, without enormous outlay, and without great offence to the ignorant. Those admitted to leper hospitals should not be permitted to return home unless cured. All families in which lepers are living, should be placed under the disqualifications and regulations already recommended under the 4th head. A suitable locality of large extent should be chosen for hospital, for cottages, for gardens, and other requirements. The better class patients should have superior accommodation, and enjoy certain privileges in return for their services in the management, attendance on, and education of the others, as is done with great satisfaction at Molokai, in the Sandwich Islands. There should be strict quarantine laws to keep the reckless and ignorant from intercourse with them. Robben Island is not a suitable locality, though its situation is good, for such a purpose. The winds are there too cold and strong; the ground is generally dry and barren. The patients not only occupy themselves in fishing, which exposes them to wet and cold, but they eat the fish caught, which, with the weekly allowance, becomes an excessive portion of their diet. A farm like Tokai, would be best for them; but it should be as well guarded as a lunatic asylum. Everything for their comfort and well-being should be done, at any reasonable sacrifice by the public. Their affliction calls for the greatest charity in every form of kindness. Large buildings would not be necessary. If the men and women were quite separated, a large area would be required; but, as they would come in gradually, accommodation could be in the same manner provided.

I will conclude these notes with the beautiful words of Canon Farrar:—"Why are the cities of Europe horrified no longer by the hideousness of *mediæval leprosy?* Because rushes are no longer strewn over floors, which had been suffered to be saturated with the organic refuse of years. Because the simplest laws of nature are better understood. Because, in these respects, men have remedied by God's aid, some of those miseries for which the Saviour *sighed*."

JAS. BAKER.

Kalk Bay Rectory,
10th August, 1883.

SCURVY IN HIGH LATITUDES

AN ATTEMPT TO EXPLAIN
THE CAUSE OF THE 'MEDICAL FAILURE' OF THE
ARCTIC EXPEDITION OF 1875-6

BY

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1876

NOTICE.

THE subject here presented to the public is cast in the form of two letters which were addressed to the Editor of 'The Times' on the 1st and 8th December respectively.

Only the first one, however, found its way into the columns of that journal. Though it does not concern the writer to know the reason why the second should have been less successful in its attempt to meet the public eye, it may not be improper to say that the able conductors of that great vehicle of public instruction had in the interval between the two—that is, on the 4th December—committed themselves to a view of the subject which was in direct opposition to that of the author, who ought not therefore to have expected that his flat and emphatic contradiction of their leading article, coming, too, immediately after it, should have received any favour at their hands.

Be this, however, as it may, the writer very gratefully acknowledges the reception of his first communication, and even thinks it his duty to allow that the second may not possibly be thought to have introduced any new points, though it certainly amplified and more fully explained those important facts which formed the basis of his argument in the first.

If, again, the length of the second letter rendered it unsuitable for the public print now referred to, the writer feels himself entitled to say that his 'physiological reasoning' could not have been more condensed without loss of perspicuity, and that, when compared with the expansion which is given to the most ordinary discussion of points, whether 'legal, political, or theological,' it may not unjustly be regarded as 'brevity itself.'

SCURVY IN HIGH LATITUDES.

No. I.

There are occasions when doctrines, even those most generally accepted, should be re-opened for discussion and subjected to the trial of extreme cases. Among these, perhaps, is the question of anti-scorbutics, so important to the health or safety of our mariners, and now brought prominently before us by the reports of our last Arctic Expedition.

No one can doubt that this great national enterprise was fitted out with every appliance which England's united wealth and science could suggest as necessary, or even desirable, both to promote the comfort and insure the health and safety of the travellers. How great, then, must have been the disappointment of those who found that it signally broke down in those very points where its success might have been thought to be best secured! Yet this failure, so unexpected by some, is exactly what others would have been led to predict or anticipate.

It is worth looking at this conflict of opinion; and the present time affords the most fitting opportunity, when so many scientific minds are naturally turned to the subject.

The doctrine which has long prevailed in reference to 'scurvy' is that the dietary of our sailors during long voyages has been defective in one important element which was deemed necessary to maintain human life in its full vigour. The idea that referred it to the 'salted' provisions has been abandoned by general consent; it is not the presence of salt, however excessive, but the absence of fresh vegetable juices, to which scorbutic weakness is generally referred. Hence the use of lime-juice to prevent the disease, and of fresh vegetables to cure it, when our stricken sailors have arrived half dead and exhausted in our ports.

This, the orthodox theory, has never been wholly unquestioned; but, apart from the arguments laid in antagonistic experience, a very valuable remark was offered many years ago by Justus Liebig, and readily adopted by the sceptics, to the effect that when animal flesh had been preserved in brine it became necessary to wash out the salt in order to render the meat possible as an article of food, and that in washing out the salt the animal juices went along with it, so that what remained to be eaten was no better than refuse. It was, in fact, flesh from which every element of nutrition had been eliminated.

Liebig would have said: 'Let your flesh be sugar-pickled, not saturated with brine; the former method

will be the most economical, for you will thus preserve everything and have your valuable sugar in addition; while the latter process leaves your meat perfectly worthless, and you may as well reject it altogether.'

This argument was valuable in showing that what was accredited as food was in reality no food at all, and went far to explain the scurvy when it occurred in long voyages. But turn we now to the disease as it befell our Arctic travellers.

All true pathology must rest on the basis of physiological science, and be in exact harmony with its principles. Now, no one will deny that our vital heat and energy are the results of consuming oxygen, nor that Nature helps our instincts in such a way that we can in ordinary circumstances maintain the temperature of our bodies at about 98 deg. without falling into disease

If we take too much food, Nature's kindness stores it up for us—that is, we fatten; at other times her caprice visits us with indigestion, and our sensuality is chastised. If, on the other hand, we are insufficiently fed, we may become the victims of scurvy. Look at the extremes of human existence. The Southern Spaniard lives on 'gaspacho,' little better than our salad; the tropical Indian on rice, with some spicy condiment; the inhabitant of the Arctic regions maintains his existence by whale-fat or blubber. The Asiatic is independent of the fatty element of food. The Esquimaux protects himself from scurvy, not by lime-juice and fresh vegetables, which are out of his reach, but by whale-fat, which Nature gives him in rich abundance. Arctic travellers and whaling captains tell us of this people 'that they are most accomplished seal and whale hunters, that they delight in blubber, and when they have obtained plenty of it they lie down on their backs to be crammed by their wives with the precious dainty, of which they are capable of devouring some 14lb. in a day.[1]

Parry tells us that an Esquimaux boy ate in twenty-four hours $8\frac{1}{2}$ lb. of seal meat, half frozen and half cooked, 1 lb. 2oz. of bread, and $1\frac{1}{2}$ pint of thick soup, washing all this down with three wine-glasses of schnapps, a tumbler of grog, and five pints of water. We smile at such voracity, or raise the eyebrow as the guzzling urchin is presented to our imagination; but is not the strange fact thus recorded the stern exigence of physiological law? Could this Arctic people be preserved on any other conditions? Would they not otherwise be swept from the face of the earth? Take a cubic foot of air at 60 deg. and another at the low temperature of 59 deg. below zero, what will be the devouring force of oxygen in the latter compared with its small amount in the former? I have illustrated this subject *ex hypothesi* in a popular lecture on Respira-

[1] See 'Quarterly Review,' October 1876. Article 'The Arctic Regions.'

tion, in which I might have done better had I substituted these real facts for my imaginary ones.[1]

In the country of the Esquimaux, and, *à fortiori*, in still higher latitudes, we must live as the Esquimaux. Huddled up as they are in ice and snow, and condemned for half the year to a perpetual night, they have few or no wants beyond blubber; this to them is all-sufficing. They ask for no lemon-juice; if they relied on this they would infallibly perish. Does not Nature make the same demand on us as she does on them in the same conditions? They answer this demand by giving her whale-fat, and she is satisfied. We tender our cup of lime-juice, but she, ever cruel and implacable towards error, smites us with scurvy for our ignorance.

In our next Arctic Expedition let us borrow the stomachs of the Esquimaux, and live like the Esquimaux.

Our mariners, when thus fortified against the ravages of consuming oxygen, will bid defiance to the scurvy. They will not ask for lime-juice from the West Indies, nor repine after the water-cresses of Hertfordshire.

November 29.

[1] Lecture on 'Respiration, or Why do I Breathe?'

No. II.

It has been playfully said of the members of my profession that even the best of us would make but sorry stable-boys, and that our services in this respect would be held in little esteem at the famed hunting-resorts of Leamington or Sherborne. This well-feathered shaft is doubtless aimed at our too frequent habit of putting the saddle on the wrong horse; still, if we are to be considered as fair game in this matter, our defence or apology must be laid in the extreme difficulty of our inquiries, for on no other ground can we be fairly exposed to such exclusive banter.

Be this, however, as it may, our sagacity at the present moment is sorely tried in fitting the saddle to the right back in this great question about 'scurvy in high latitudes.'

In my last letter (Dec. 1) I endeavoured to point out the lines of philosophic thought on which the solution of this interesting problem must be sought, and I referred your readers to the great unquestioned fact of the immunity of the Esquimaux from that disease, which has proved the scourge of our Arctic travellers.

My argument was:—The Esquimaux are men like

ourselves; take them to pieces as the anatomists do, we find no difference between us. Oxygen and carbon must be to them exactly what they are to us; surely, then, we are in the same physiological boat. An Esquimaux brought within the temperate zone must forego his Arctic life, or he will speedily become diseased and perish. A European, when transferred to Arctic regions, must adopt the life of those latitudes, or the same fate will inevitably await him.

It has been said, 'I grant your case in regard to the Esquimaux, but you cannot thus bridge over the gulf which separates him from the European. The Esquimaux, I admit, is independent of fresh vegetables; experience proves it to be otherwise in the case of Europeans.' This objection is a double-edged one; but on one side it is fanciful, or gratuitous and unfounded, and therefore requiring no further answer than what I have already given; on the other it involves a '*petitio principii*'—it asks us to concede the very question in dispute. On one side it denies the physiological identity of the Esquimaux with ourselves; on the other it asserts the need of lime-juice, or fresh vegetables, which is the very point we have to try.

The object of my letter to-day is not so much to offer facts as to place before your readers the scientific bearing of those to which I have already referred. Still, as facts are of so great value, you will perhaps allow me to add one or two to those I have already given.

One of your readers—a gentleman high in the civil service of the Navy—on reading my letter of the 1st inst., sent me the following:—

'In one of his [Sir John Richardson's] expeditions, he found his men losing strength very rapidly, although in full allowance of provisions, and becoming daily more and more dispirited without any assignable cause. At the same time he observed that the Esquimaux of his party were thriving and jolly as usual; they were living on blubber, and when he persuaded his men to take to the same kind of food, they rapidly recovered.'

It is very rare for London physicians to see cases of scurvy such as they are presented at our seaports.

Still, having been for many years physician to the old 'Dreadnought,' I am as familiar with it as with the most common diseases of our London hospitals. In many cases which I had to treat there I never thought or found it necessary to give my patients any of the so-called anti-scorbutics, but found that milk, soft bread-and-butter, anything, in fact, that was suitable for very tender gums, was all that was required for their recovery in the first instance. After a time, no doubt, when their cure was more than half effected, they had the ordinary diet of convalescent patients, which included potatoes or other articles of supposed anti-scorbutic virtue.

It happened to me once to have some patients

from a ship which had been shamefully provisioned in other respects, but yet was furnished with lime-juice. The men were badly stricken. I asked one of them if the scurvy, which had so severely fallen on them, made great ravages in the cabin. 'Did the captain, the mate, or the cook suffer much?' 'No, the d——d rascals,' was the blunt reply; an expression which clearly meant that the good things of the cabin had not descended to the forecastle. Let such facts suffice, and pass we now to their scientific bearing.

The living being—'man'—is simply a machine, which is to do so much work, and maintain itself at a temperature of about 98 deg. The whole gist of our great question lies in this little nutshell.

To keep himself up to 98 deg. is man's paramount necessity. The barbarian does this by an instinct which is successful; our imperfect knowledge leads us astray, and we miserably fail. What, let us ask, is the secret of the barbarian's success? He lives on blubber—it is nothing else. His temperature is not higher than ours, his work is not greater. The pounds of whale-fat he has consumed have gone out of his body by the breath—i.e. in water and carbonic acid. It is this combustion of his food which has kept up his temperature, whilst his body at the same time has maintained its integrity. He does not fatten under his gross feeding; he remains the same whilst in health. By his breath he has pulled in just so much oxygen as has sufficed to burn the oil which is required to do his mechanical work and keep his body up to 98 deg. The amount of oxygen which is necessary for him to do this is the exact amount which is necessary for ourselves in the same conditions.

With such knowledge before us, let us now listen to the voice of Nature. She, ever faithful to her duty, thus addresses our Arctic travellers: 'You ask of me that I shall maintain the heat of your bodies at a temperature of 98 deg, when the thermometer stands at 60 deg. below zero. I am ready to do this; I do it for the Esquimaux; I will do it also for you. I will send into your bodies just so much oxygen that shall kindle a fire which will be exactly equal to the effect. That is all I can do—it shall be your duty to supply the fuel; but, mark me, if you give it not in food, I will rend it out of your bodies by force; for as long as you have life, I will have it, and will take it even to your destruction.'

Need we invoke mathematical aid to prove that a cup of lime-juice will not satisfy this demand, nor that it will utterly fail to meet the claims of so much oxygen as shall convert a bladder of lard or a gallon of oil into its equivalent of water and carbonic acid?

When a person has something disagreeable or painful to communicate, kind feeling demands that he shall 'break the news' softly, and thus avoid all unnecessary offence. My first letter was therefore couched in language of studied gentleness. I spoke with almost

'bated breath, and whispering humbleness.' Such speech was proper at the time, but would not become me now. When a great principle is at stake—when the public mind has to be disabused of a mighty error, to which it fondly clings with such tenacity, even hugging it to its own destruction—to make a truce with falsehood would be treason; there cannot be even the semblance of a compromise. It is therefore my duty to proclaim in language that cannot be misunderstood that the doctrine of anti-scorbutics is utterly rotten and untenable; it is indeed the last remnant of a bygone and obsolete physiology. There is now NO anti-scorbutic, or, in other words, all food is anti-scorbutic, though in most unequal degrees. Fat and oil stand at the head of the class, of which whale-fat or blubber is perhaps the best representative. Sugar has a high place in the scale, containing as it does some six pounds of carbon in every fifteen pounds. Potatoes rank high (*testetur Hibernia*) on account of its starchy elements, so readily convertible into glucose.

Lime-juice, long esteemed the '*dux summus*' of the class, stands very low indeed. It would be inferior to barley-water in keeping scurvy at bay, and would be on about the same level with toast-water. Take a puncheon of it, evaporate it to dryness, weigh the residue:

> Expende Hannibalem, quot libras in 'duce summo'
> Invenies?

Burn it, reduce it to ash and carbonic acid; ask the chemist how much oxygen it has taken to do this, and he will tell you to a decimal of a grain.

Whatever answer he may give you, that will represent its anti-scorbutic virtue.

He who shall write a philosophic history of medical science, and shall possess the genius to perceive what lights have arisen from time to time, making the dark things of the past to shine with the brightness of noon, will tell us—that the chemistry of Liebig and of Liebig's time made physiology a new science,—that it completely transformed it,—and that, amongst other benefits it conferred, it forged a weapon which gave the death-blow to the doctrine of anti-scorbutics, just as the theory of Phlogiston fell before the burning light that was shed abroad by the discoveries of Priestley.

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CAN INDIA BE COLONIZED BY EUROPEANS?

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Thomas Longmore Esqre
with the Author's kindest regards

CAN INDIA BE COLONIZED BY EUROPEANS?

Reports from the Select Committee on Colonization and Settlement (India); with the Minutes of Evidence taken before them: 1858.

2. *Could the Natives of a Temperate Climate colonize and increase in a Tropical Country, and* vice versâ? By Arthur S. Thomson, M. D. *Transactions of the Medical and Physical Society of Bombay for* 1843.
3. *A Brief Review of the means of preserving the Health of European Soldiers in India.* By Norman Chevers, M. D. *Indian Annals of Medical Science:* 1859.
4. *On Ethno-Climatology; or the Acclimatization of Man.* By James Hunt, PH. D., *in the Report of the Thirty-First Meeting of the British Association for the Advancement of Science, held at Manchester in September* 1861.
5. *Introduction to Anthropology.* By Dr. Theodore Waitz. Edited by J. Frederick Collingwood, 1863.

THE question—*Is it physically possible to colonize India by Europeans?* comes home, in some way or other, to the feelings or the interests of every man dwelling between Cape Comorin and Peshawur. The enterprising speculator, the world's pioneer, seeks in Assam and Cachar, in the Dhera of the Dhoon, upon the slopes of the Himalayas, of the Neilgherries and the Shevaroy Hills, for lands, which, although now waste and of low value, promise, hereafter, under the skilled labour of the British agriculturist, to become the sites of such tea plantations as China never saw, and of cinchona forests, in comparison with which the ill-regulated and failing bark-supplies of the Peruvian Andes will be but as withered leaves and rotten wood. The English mother, as she gazes—how possibly for the last time in this life—on the sweet little white face and tearful eyes of him who, yesterday, was the tyrant and the darling of a Mofussil bungalow or a Calcutta mansion, now ranged with some fifty other troubled little white faces down at the Outer Floating Light, around the tables of our Toynbees and our Daniells, turns away from the fatherly assurance of the kind seaman's voice, and sobs, 'Has God set apart no place in India, where my child might 'live?' Our Government—deeply conscious of the terrible fact that, in their European Army stationed here, every regiment has lost, by death, on an average, a company,—one bayonet in every ten,—every twenty months during the last hundred years,—is earnest in seeking out cool and elevated spots, where their troops may be advantageously posted out of the fierce rays of the sun and above the range of the deadly fever-steam.

It is known to this benevolent Government that, in the barracks of the Plains, the mortality among their soldiers' children, of pure European race, more than trebles that frightful death-rate which prevails among the infants of the poor at home. They, therefore, at the instigation of Henry Lawrence, maintain schools for soldiers' children at Sanawur, Murree, Mount Aboo, and Ootacamund, and are, we believe, deeply solicitous to save many more of these little brands from the burning, and to rear them in the Hills to become, hereafter, wielders of their fathers' arms.

The same Government, perceiving how greatly the extensive introduction and wide diffusion of an European industrial element in India would tend to develop the vast and still almost uncomputed resources of this country, equally to the benefit of the natives and of ourselves, seek anxiously to ascertain whether there are not extensive tracts of country in the three Presidencies, where the stout agriculturists of Britain may form colonies, and fields, and homes, and rear around them a race at least equal to themselves in vigour and intelligence.

Thus it will, we think, be perceived, even from these few and very scanty illustrations, that there are not many amongst us whom this question, as to the practicability of colonizing India by Europeans, does not practically concern.

Wherever a nation has assumed a forward place among the dominators of the world, it has become a centre of immigration. It has sent forth its armies to conquer new lands; and, in those subjugated territories, it has established, on a more or less extended scale, commerce, its own standard of civilization, its language, its arts, and often its religion.

In eliminating these first elements of colonization, we begin to perceive the wisdom and goodness of the Almighty in placing swords in men's hands. Here the natural development of God's ordinance provides that, at no distant period, the falchion of the invader becomes changed into the reaping-hook of the colonist.

All the nations with whose histories we are fully acquainted have been peopled by a succession of what may be termed immigrant waves. Everywhere, whether by warlike invasion or peaceful immigration, race has followed and supplanted race.

Into Britain flowed successively, during a course of centuries, the armies and the colonists of the Roman, the Dane, the Saxon, and the Norman, dispossessing and supplanting the Celt, (who clearly owed his origin to some race of Aryan strangers from the East,) and driving him into the remote mountainous fastnesses of the land.

In India, the Turanian (doubtless, himself, an interloper from the North and East,) has been, in like manner, displaced by the early Aryan, the Hindu, and the worshipper of Mahomed, among whose descendants the power of England has, for the last century, been paramount.

The text-word of the world's history is PROGRESS. Throughout all time we perceive mankind ever pressed forward by a Divine impetus towards a standard of perfectibility fixed by the All-Wise.

Our Faith and our Science combine to teach us that the life of the world is, like our own lives,—finite.

As it has been ruled that intellectual man shall, in passing from his cradle to his grave, accumulate knowledge, experience, skill, the power of fitting his mind for that immortality which is its sure inheritance, so the spirit of the world, emerging from infant barbarism, steadily advances, by arms, by arts, by civilization, and by the spreading of the True Faith, towards that happy millennium which has been promised as the crown of its green old age.

Like the life of the world, and the life of every man and animal inhabiting it, the life of every nation (with perhaps one exception) is but a finite thing. Excluding the instance of that peculiar people, the Jews, we find all historical experience demonstrating the fact that every nation, be it strong or weak, has its period of infancy and also its term of senility—upon which, sooner or later, its political death ensues.

Carrying on the analogy, without at all overstraining it, we may say that Colonization and Settlement are to the nation what birth, marriage, and death are to the individual. The first shout of the immigrants, when they see stretched before them the plains of that promised land towards which they have travelled from afar, is the same as the first cry of the infant at its birth, the first self-gratulatory murmur of the heir when he enters upon his inheritance. The extensive settlement of foreigners in a nation is that nation's marriage, whereby it extends its alliances, whether for good or evil, and, by an intermingling of races, either improves or deteriorates its population. Again, if any law in the history of mankind can be looked upon as fixed

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and certain it is this:—Whenever a country becomes the seat of extensive and successful colonization, its former occupants, with the exception of a scattered remnant, speedily die out. The old man passes away, and the heir reigns in his stead.

Whether this last result be the development of an immutable natural law, or the avoidable issue of certain errors on the part of the conquerors and the conquered is, however, a questionable point, which we are not called upon to discuss here.

What may be termed the instinct of colonization,—that impulse to go forth, discover, and conquer, and then to multiply in and replenish new territory,—has been implanted by the Creator in all animated beings.

As surely as the fledgeling, conscious of possessing the gift of flight, casts himself from the nest and spreads his pinion to the breeze, as certainly do many of the tall sons go forth from the castle and the homestead, never to meet sire and mother again, until fame and fortune have been won, or until, at the sounding of the last trump, the sea shall give up its dead, and the voice of an archangel shall call over the muster-roll of those who have died in battle for their countries' cause. That same power, which sends the dragon-fly from the alders to hover above the mill-stream, and to spend the few bright hours of its existence among the wild flowers on the other bank, mans our navy and recruits our army. The same God-implanted instinct which, yearly, leads hundreds of delicately nurtured children to tear themselves from their mothers' arms and to dare the sufferings and the perils of a seaman's life, urged Humphrey Gilbert—ever intent upon the discovery of a North-West passage to India—forth upon his last voyage, and prompted his dying cry in that dreadful tempest which swallowed up his ship—'Courage, my lads, we are as near heaven at sea as on the land.' This noble instinct, we may be assured, sustained Franklin and the learned, brave and devoted men who accompanied him upon his quest straight into the unknown region of eternal snow, right onward even unto death.

A practical-minded modern writer states the case very much as it stands, being content with the fact without troubling himself about the reasons, when he tells us that 'It is the genius of 'our restless, discontented English nation to go blundering about 'the world like buffaloes in search of fresh pasture.'

This migratory spirit has ever been most actively aggressive among the young, the strong, and the ardent of the dominant races. It assumes every form, from the noblest to the basest,—patriotism, ardour for conquest or for the propagation of religion, scientific zeal, independence, curiosity, daring, love of travel and adventure, ambition, cupidity, the greed of gain. Divested of this instinctive migratory spirit, this stirring of the Viking blood, no country could ever assume the position of a military, naval, or mercantile power.

We need not occupy much time in explaining the broad, practical difference which exists between *Settlement* and *Colonization*. The settler enters a foreign country as a guest, sometimes as an intruder, or, at least, distinctively as an alien. The colonist goes in and occupies as an invader or an heir.

Settlement is, of course, colonization on a small scale, and the less frequently runs into the greater.

In these remarks, we shall understand that the *Colonist* is one who, adopting a new home in a foreign country, determines that he and his children's children shall continue to inhabit that land as their own proper and permanent abiding-place. We shall consider that the *Settler* is one who merely holds himself to be a bird of passage, a foreigner, and temporary sojourner, still belonging to his native country. The Pilgrim Fathers, who, in 1619, landed from the Ship *Mayflower* on Plymouth Rock, in Massachusetts Bay, were colonists. We Britons, who pass a certain number of our years in India with an energy proportioned to our expectation of being allowed to die at Home, are settlers.

No race can be regarded as colonists in a land, the climate of which is such as to preclude them from fully engaging in field labour.

It is a very remarkable and certain fact that the Creator has laid down a system of purely physiological laws, (into which we, as ethnologists, are only now beginning to obtain an insight); which laws most potentially limit and control man's power of settling in and colonizing foreign lands.

For the sake of practical illustration, these laws, or rather their manifestations, may be divided into three leading classes.

1. Those which freely permit and encourage Settlement and Colonization.

2. Those which utterly prohibit either Settlement or Colonization.

3. Those which, permitting Settlement, absolutely forbid Colonization.

Let us briefly consider these laws in detail. *First*, those which freely permit and encourage Settlement and Colonization. The strongest type of these laws may be found in those passages of Scripture which lay down the conditions under which the people of Israel, emigrating from Egypt, colonized the Holy Land.

Behold I have set the land before you, go in and possess the land.—*Deut.* i. 8.

The Lord thy God bringeth thee into a good land.—*Deut.* viii. 7.

I will give you the rain of your land in due season, the first rain and the latter rain, that thou mayest gather in thy corn and thy wine and thy oil.—*Deut.* xi. 14.

Then will the Lord drive out all those nations from before you and ye shall possess greater nations and mightier than yourselves.—*Deut.* xi. 23.

Every place whereon the soles of your feet shall tread shall be yours.—*Deut.* xi. 24.

There shall no man be able to stand before you, for the Lord your God shall lay the fear of you and the dread of you upon all the land that ye shall tread upon.—*Deut.* xi. 25.

By little and little I will drive them out before thee, until thou be increased and inherit the land.—*Exod.* xxiii. 30.

The Lord God of your Fathers make you a thousand times as many more as ye are, and bless you, as he hath promised you!—*Deut.* i. 11.

There shall not be a male or female barren among you, or among your cattle.—*Deut.* vii. 14.

Blessed shalt thou be in the city, and blessed shalt thou be in the field.—*Deut.* xxviii. 3.

Blessed shall be the fruit of thy body, and the fruit of thy ground, and the fruit of thy cattle, the increase of thy kine and the flocks of thy sheep.—*Deut.* xxviii. 4.

In blessing I will bless thee, and in multiplying I will multiply thy seed as the stars of the heaven and as the sand which is upon the sea-shore.—*Gen.* xxii. 17.

And the Lord will take away from thee all sickness.—*Deut.* vii. 15.

Your threshing shall reach unto the vintage, and the vintage shall reach until the sowing time, and ye shall eat your bread in the full, and dwell in your land safely.—*Levit.* xxvi. 5.

I will rid evil beasts out of the land, neither shall the sword go through your land.—*Levit.* xxvi. 6.

It will here be seen that the Creator, from whose liberal hand flow all the blessings of life, strength, health, and wealth which we enjoy, favoured the physical circumstances of his chosen people, the Jews, in a preternatural manner upon their entrance into the Land of Promise. The extremely rapid increase of the immigrant race is, however, even in the present day, the leading test of success in colonization. Thus we are told that England doubles the number of her people in about one hundred

years, Scotland in about one hundred and fifty; in America, not many years ago, they were being doubled in about twenty-five years; and it is reckoned that, in less than ninety years, if the rate of increase which prevailed before the present lamentable war continues, the American population will be more than two hundred millions. We, however, know that, whenever a country becomes adequately peopled, the rate of increase in its population abates. In 1790 the United States contained less than four millions white inhabitants. In 1840 this population had risen to upwards of seventeen millions. The rate of immigration into the United States from Europe was quite inadequate to account for this great and rapid increase.

Some idea of the manner in which the population increases in healthy and prosperous colonies may be obtained from the following obituary notices which appeared in one page of the *Gentleman's Magazine* for March 1791:—'1789, at Northampton, 'in Massachusetts, in North America, aged ninety-two, Mr. Josiah 'Clark. He was the youngest of eleven children (six sons and five 'daughters), three of whom lived to be above ninety, four above 'eighty, and three above seventy years of age. From the six 'sons only have descended 1,158 children, grand-children, and 'great grand-children, of whom 925 are now living.

'*December.*—At Dedham, in Massachusetts, aged ninety-two, 'Captain Ezra Morse. He had 262 descendants, of whom 216 'survived him, and of these, thirty-five were of the fifth generation, several of whom have reached their fifteenth and sixteenth 'years.'

At present this remarkable law of prosperous increase is said to be most remarkably prevalent in California.

We cannot but think that a study of the laws of population in thriving colonies, to which we have now so slightly alluded, would lead Bishop Colenso to qualify much that he has so confidently stated, especially in his 17th Chapter, on 'The number of the 'Israelites at the time of the Exodus.'

In alluding to the fact that, under their admirable system of discipline, the Roman soldiers maintained health and vigour in all climates, including parts of Asia and Africa, Gibbon remarked that 'man is the only animal which can live and multiply in 'every country, from the Equator to the Poles;' this truth has to be received with many and considerable qualifications.

It is unquestionable that, even under the most successful circumstances of colonization, as for example in the great European colonies of North America, Australia, and the Cape of Good Hope, the later colonial offspring display a very general and manifest tendency to degenerate physically from the robust and vigourous type of the original parent stock. This falling off is principally displayed in deficiency of muscle and remarkable slenderness of figure, and in that tendency to the early decay of the teeth, which renders the profession of dentistry so flourishing an undertaking in most of the Colonies.

It is, indeed, held by some very high authorities that the races of men can thrive and permanently maintain themselves only in those localities to which they appear originally to belong. There is a foundation of truth in this idea, but we think that the rule can only be rigidly applied to those who colonize regions, the climate of which is very different from that of their native land. A very able writer thus states the extreme view—'Is the Spaniard 'thriving in South America, the Celt or the Saxon in the Northern 'half? Is there true Colonization in India? Does the English-'man flourish in the islands of the Gulf of Mexico? Could the 'Negro inhabit Lapland, or could the Northman long flourish on the Senegal or Gambia? Is the Red Man fitted for a large 'portion of the Western Hemisphere, and does the White Man wax 'strong amidst the forests of the Far West? Is the standard of 'health as high among the inhabitants of the Union as it is among 'their progenitors' [brethren ?] 'in the British Isles? To point 'to quarters of the globe at present peopled by races foreign to 'the land, and apparently flourishing commercially, as facts 'opposed to such doctrine, is to be open to the reply that annually 'into these countries have been and still are imported thousands 'upon thousands of immigrants representing some of the best blood 'of the colonizing stock. To be able to form a satisfactory conclu-'sion, this constant replenishment must be arrested, and a 'sufficient length of time allowed to elapse to enable us to see how 'the foreign race could then propagate and maintain itself in its 'adopted clime. We believe it would fail and generally die out, 'and that the period would come, however distant, when the 'Saxon would no longer be found in Australia, in Kentucky, in 'Tennessee. Again, we all know that, in the usual places of 'resort of Europeans within the tropics, the aliens can continue 'to reside with comparative impunity if moderate caution be 'adopted. But this is all, whether it be the Rio Formosa 'or the Rio Colorado, Ashantee, or Madras, whether it be Bengal 'or Jamaica, Cape Town or Canada, Hispaniola, Chili, Cuba, 'or Peru, no true European stock can *permanently* colonize the 'place. We have held India for more than two hundred years, 'yet we cannot colonize an inch of it. We have planted the 'white man in America, and there he degenerates!'

It is strikingly remarkable to how very short a distance, whether north or south of his own proper habitat or ethnic circle, man can remove without sustaining considerable detriment. In the paper on Ethno-Climatology, the title of which stands at the head of this article, Dr. James Hunt shewed that the English, when sent to any part of the Mediterranean, suffer far more than in England. It has been proposed to locate British troops at the Mediterranean stations for a time before they proceed to India. This authority suggests that, under such an arrangement, the soldier might gain some advantage in acquiring those habits of caution which a hot climate demands, but he, with great show of justice, apprehends that, if the troops were located in the Mediterranean for a few years before coming to India, the mortality would be far higher when they arrived here, as a large proportion of the men would land with deteriorated constitutions.

Having thus given a mere glimpse of the laws which govern Colonization and Settlement in their more successful aspects, we shall now allude to those which utterly prohibit either Settlement or Colonization.

All countries in which there is much of that deadly poison or miasm, generated in marshes, which gives rise, in its mildest and simplest form, to ague, and in its more concentrated and pernicious developments to dysentery, remittent fever, and cholera, are peculiarly unfavourable to strangers. Thus it very rarely indeed happens that any stranger, whether Native or European, fails to suffer, more or less, from illness during the first month of his sojourn in Calcutta. There are tracts in the Himalayan Terai country where, although the aboriginal inhabitants contrive to exist, all settlers from outside either die or are driven out by disease. Other parts of the Terai are absolutely uninhabitable, and can only be entered at certain seasons. Most of our readers must retain stamped upon their memories Lord Macaulay's last great word-picture,—his narrative of the Darien calamity in 1699. Lured on by the brilliant speculations of an honest but over-ardent financier, and by very narrow historical research chiefly into the accounts of missionaries and pirates, who appear to have visited Dárien only during the healthy season, and to have described it as a paradise, unaware or regardless of the warnings contained in the works of Hakluyt and Purchas, which shewed that Darien was noted, even among tropical climates, for its insalubrity,—twelve hundred seamen and colonists embarked from Leith in the summer of 1698, determined to form a settlement upon that narrow isthmus which unites the North and

South American continents, their design being to construct roads along which a string of mules or a wheeled carriage might, in the course of a single day, pass from the Atlantic to the Pacific Ocean, concentrating in that point the whole traffic between India and Europe, thus securing what Sir John Dalrymple called ‘the Gate of the Oceans,’ and wholly obviating the necessity for the tedious and dangerous voyage to India and China round the Cape of Good Hope. They reached their destination in November, and established their settlement of New Edinburgh on a small peninsula. The accounts of the first settlers were so encouraging that, in the following August, thirteen hundred more adventurers embarked to join them. Two months later, it was known in London that the Colony of New Caledonia was no more, and that only a few men, broken alike in spirit, fortune, and constitution, had found their way to New York, muttering the tale of a destruction only surpassed by that which the waters of the Red Sea concealed from light. During the cool months which immediately followed their landing, but few deaths occurred; but, before the equinox, pestilential marsh fevers became prevalent, and the deaths gradually increased to ten or twelve a day. Those who were not laid on their beds were so broken by disease as scarcely to be able to move the sick and bury the dead. The shattered remnant embarked on three ships. Upwards of three hundred and ninety persons died on the voyage to New York. Meanwhile, the second expedition reached Darien about four months after the first settlers had fled. ‘They had,’ in the words of the great historian, ‘expected to find a flourishing young town, secure ‘fortifications, cultivated fields, and a cordial welcome. They ‘found a wilderness. The castle of New Edinburgh was in ‘ruins. The huts had been burned. The site marked out for ‘the great capital, which was to have been the Tyre, the Venice, ‘the Amsterdam of the eighteenth century, was overgrown ‘with jungle and inhabited only by the sloth and the baboon.’ They, however, re-occupied the ruins and commenced repairs. ‘The months which immediately followed their arrival were,’ we are told, ‘the coolest and most salubrious of the year.’ But, even in those months, the pestilential influence of a tropical sun shining on swamps rank with impenetrable thickets of black mangroves, began to be felt, and the mortality was great. Before the end of March they were compelled by the Spaniards to evacuate their settlement. They departed early in April, having lost by disease, in the four healthiest months of the year, three hundred men out of thirteen hundred.

We have evidences of the fact that, where a sufficient number of human lives have been expended in the destructive labour of improvement, spots quite as pestilential as New Caledonia have been made inhabitable; but this has no special bearing upon the point in question, as, practically, it is impossible to form settlements, much less colonies, in such localities.

We shall now, in considering the developments of those laws, which, permitting settlement, absolutely forbid colonization, begin to deal with the question immediately before us;—the Settlement and Colonization of India by Europeans.

It has been truly remarked by Dr. William Aitkin, that the white races reach their highest physical and intellectual development, as well as most perfect health and greatest average duration of life above 40° in the Western and 45° in the Eastern Hemispheres; and that, whenever they emigrate many degrees below these lines, they begin to deteriorate from increased temperature, either alone or combined with other morbific influences incident not less to change of climate than to habits of life. In a tropical climate, like that of India, the European is literally, ethnologically, and physically, an ‘Outsider’ and ‘Interloper.’ He is, in no sense of the term, a colonist. He is scarcely even a settler; because he can never permanently settle down in a climate, the nature of which is so absolutely inimical to himself and his progeny. He must ever be an ‘adventurer’ in the land, adventuring his life with the absolute certainty of having a greater or less portion of it curtailed by the slow or rapid destructive influence of a climate to which his constitution can never thoroughly adapt itself. It was long believed that this adaptation of the constitution to climate, or acclimatisation, was a law of nature constantly operative among settlers in tropical climates. But no European ever becomes truly acclimatised in India; the shock of the first change from a cool to a hot climate has to be got over, and many, by learning the proper mode of living in the country, enjoy better health after a few years' residence than they did on first landing; but, as a general rule, the rate of mortality increases in proportion to the length of residence in India.

In like manner, Dr. Armstrong and others (as cited by Mr. James Hunt) have observed that Europeans resist the cold of the polar regions better the first year than they do the second, and that every subsequent year they feel the effects of the climate more. Further, Dr. James Hunt has amply proved, by statistical evidence, that, as age increases, so does the mortality in any place out of the native land of a people.

The injurious influence of tropical climates is not at all confined to the human race; the lower animals share it equally. English dogs, horses, and kine are generally unhealthy and short-lived in the East and West Indies, and their breeds cannot be maintained.

We shall consider as proved and granted the facts that the mortality among Europeans in India largely exceeds the Home rate, and that the annual death-rates from the most prevalent diseases, such as dysentery, inflammation of the liver, cholera, and pulmonary consumption, are, by a very large amount, higher among our European troops in this country than they are among the Sepoys.

We have already hinted that no body of men deserve to be regarded as colonists in a country where, feeling themselves incapable of enduring the necessary toil and exposure, they are compelled to engage the services of the natives of the soil in that field labour, without which the existence of a community can nowhere be maintained.

Few men can regard themselves as absolutely independent of the assistance of their fellow-men, but if there is any human being in the world who ought to feel that, to live, he must, under Providence, be absolutely self-reliant, it is the colonist—the opener out of new lands. Recently a local journal, in commenting upon some judicious but by no means novel views lately propounded by Dr. Lewis upon the restorative influence of the sun's rays in certain diseases, remarks:—'We have always thought that 'soldiers in India, and indeed Europeans in general, are too much 'afraid of the sun, and would be far more robust if they exposed 'themselves to its rays more than they do. It is not the sun 'that kills our men in India, but the seclusion to which they 'are restricted to avoid its effects, and the course of diet they 'pursue.' Here the remark on diet is not without justice, but the writer falls into the great mistake of confounding the sun's light with the sun's heat. The unwise experiments here recommended have been tried in India only too frequently. In their results they have resembled those of the man who attempted to keep his horse without food, and of the Czar Peter, who imagined that children could be inured to drinking sea-water. Just as the experimenters began to grow most sanguine, those experimented upon died. Hear what Dr. James Hunt has lately said on this point:—'Many writers have observed that, with the natives, 'those most free from disease are those who toil all day in the 'burning sun with no covering at all to the head. Ignorance as 'to the difference of race has induced some commanders to attempt

'thus to *harden* the Europeans, with results something frightful 'to contemplate. One of the regiments that had been longest 'in India, the Madras Fusiliers, is stated to have been reduced 'from eight hundred and fifty to one hundred and twenty fit for 'duty.' Many similar cases have been produced by needless exposure. Mr. Jeffreys says that 'Her Majesty's 44th Regiment, 'in 1823, were 900 strong, and a very fine body of men. The 'Commanding Officer insisted that confinement of the men during 'the day was effeminate, and continued drilling them after the hot 'season had begun. But the men suffered the penalty of the 'officer's ignorance.' 'For some months,' says Mr. Jeffreys, 'not 'less than one-third, and for some weeks, one-half of the men 'were in hospital at once, chiefly with fever, dysentery, and cholera. 'I remember to have seen, for some time, from four to ten bodies 'in the dead-room of a morning, many of them specimens of 'athletes.'

Every medical man who has seen much practice in India knows that natives are frequently killed by sun-stroke, and we may take it for granted, that nowhere in India, whether in the Shevaroy Hills, at Ootacamund, or in the Dhera of the Dhoon, will any circumstances of season, temperature or altitude justify us in employing Europeans continuously in field labour.

One of the chief impediments to the colonization of India by Europeans is the almost absolute impossibility of raising healthy children in the plains. Nearly every one understands this, practically and painfully, and the following illustrations of the fact are, doubtless, familiar to many of our readers.

According to Major-General Bagnold, the oldest English Regiment, the Bombay 'Toughs,' notwithstanding that marriages with British females are encouraged, have never been able, from the time of Charles II. to this time, to raise boys enough to supply the drummers and fifers.

In giving evidence before the Select Committee of the House of Commons on the affairs of the East India Company in 1832, Colonel Charles Hopkinson remarked that, when he was a subaltern in his Corps, it was his custom and duty to go round the places where the Europeans lived, to see that they were comfortable, and had got their houses and streets clean. In going there so frequently, he had an opportunity of seeing children in great numbers of pure European blood, yet, as long as he had been in the service, *he could not recollect above one instance where one of those children attained maturity.* The circumstance made a deep impression on him, and, for many years, he made enquiries on this subject, but he never could ascertain that, in any Corps, the children ever lived; if they did, many would then have borne arms or been serving in the public offices. This struck him the more forcibly from the circumstance of many young men who have come out as recruits in the artillery, wanting to get their discharge, to obtain which it was necessary a substitute should be provided. Now, if any, even a very small, proportion of those children born had lived to attain the age of maturity, there would have been no difficulty whatever in getting substitutes; but he never knew or even heard of one single instance, in the Madras establishment, where one was so procured, or where a man born in India, of pure European blood, ever attained an age sufficiently mature to be taken as a substitute.

So long ago as the year 1835, Dr. Twining, of Calcutta, published the question, 'Does the third generation of the European race exist in India, all the individuals being of pure 'European descent, and having been born and reared in this 'country?' This plain question has been known, probably, to every medical man throughout India for nine and twenty years. Many medical officers long engaged with European troops and attached to invalid depôts, have, to our knowledge, been greatly interested in its investigation, but, in no single instance has it ever been answered in the affirmative.

Of late years, much has been done to improve the condition of the European barrack children in the Military Stations of the plains of India, and the facts above stated and many others of equal significance led to the institution of those noble charities, the Lawrence Hill Asylums. We have, however, already shewn that, in the plains, the mortality rate among the barrack children is enormously high. (Here we must bear in mind Mr. Simon's remark,* that 'it cannot be too distinctly recog'nized that a high local mortality of children must always 'necessarily denote a high local prevalence of those causes 'which determine a degeneration of race'), and it is much to be doubted whether, in its politico-economic point of view, the experiment of bringing up soldiers' children in very remote hill stations, at a cost for which gentlemen's children could be boarded and educated for professions in Europe, can fairly be regarded as any part of a working system of true colonization.

Many of the details contained in the periodical reports of the Lawrence Asylum are very interesting and encouraging. Thus,

* Preface to Greenhow's Papers on the 'Sanitary Condition of England,' cited by Dr. Moore, of Bombay.

in that of the Mount Aboo School, for the year before last, it is mentioned that only three children have died there in nearly eight years, during which the strength of pupils ranged from twenty in 1855, to from fifty to sixty in 1860-61. The general appearance and development of the little ones are said to display the beneficial results of their sojourn in so favourable a climate. During the year under report two of the eldest boys, aged fifteen and a half and sixteen years, were provided for, and two girls were married at the respective ages of sixteen and seventeen years.

On the other hand, the cost of this experiment must again be adverted to. It cannot be anticipated that the average of European colonists in India could afford to pay, say £20 to 25 annually, for the maintenance of each of their children in the Hills. Those who could do so would much prefer to send their children home. Two years ago, Mr. Walker, of Bombay,* shewed that the revenue of the Byculla, Poonah, and other Bombay Schools would afford £22 11*s.* 7*d.* per head annually, and argued that, with such a revenue as this, the soldiers' children could be well fed, clothed, and educated in a fine healthy part of Yorkshire, where food, fuel, and clothing are cheaper than in any other part of the world. The experiment of the Lawrence Schools is so new that we are still not in a position to judge how far the children brought up in these isolated spots, within or not many degrees above the tropic line, will equal their English cousins in mental and bodily vigour. In writing on the climate of the Neilgherry Hills, Dr. Mackay remarks—'Children 'brought up here, apparently strong and healthy in their youth, 'in after years shew constitutional weaknesses, and this I have 'observed to be the case particularly with females.'

Further, it is greatly to be feared that the best of our Hill Sanitaria will, the longer they are occupied, and the more the various insanitary influences almost inseparable from residence within very limited spaces accumulate about them, lose much of that reputation for great salubrity, which, in every one of them, with the exception of Darjeeling, Nynee Tal, and Murree, is already on the wane. The extra-tropical hill Sanitaria of the Bengal and Bombay Presidencies generally afford but little dwelling space for large bodies of men, and we have strong medical grounds for believing that, should these localities ever become overcrowded, maladies partaking of the most malignant characters of the diseases of both cold and tropical climates will attack the settlers.

* The *Times of India* for November 25th, 1861, as cited by Dr. W. G. Moore, of Bombay.

In the mountain Sanitaria of Madras, the pernicious influence of a fierce tropical sun, which no elevation or atmospheric rarefaction can wholly counteract, will always prove an insuperable obstacle to Europeans seeking to maintain themselves by labour in the open air.

It is by no means certain that the climate of these great altitudes would, in the long run, prove favourable to any race, whether European or Native, immigrant from plain countries. It is known that, although the native Peruvian thrives and remains free from pulmonary complaints at an altitude from 7,000 to 15,000 feet above the level of the sea, such altitudes, as in Quito, are frequently destructive to the white.* D'Orbigny goes so far as to assert that in Peru, at the altitude above mentioned, the form of the trunk is changed by the influence of respiration, the body is short but compact, whilst the inhabitants of the damp lowlands are more slender in form. Recognising the fact that the anatomical construction and physical constitution of every animal is distinctly adapted to that habitat in which Providence has located it, we have the strongest doubts whether any people, coming from the plains of Europe, could successfully colonize the mountains of India.

The world has never yet seen a truly successful attempt to colonize, in anything like an adequate sense of the term, a tropical district by Europeans, and here it must be borne in mind that all the extra-tropical country of our three Presidencies is visited by an almost more than tropical heat and by the worst tropical diseases. The only instance of the apparent success of such an undertaking is that of the Spaniards, who have been, for many generations, settled in tropical America. The evidences of this success, however, are neither strong nor encouraging. Upon this question Dr. Hunt has the following very striking remarks:—"Some authors think that the question of the European
" propagating himself in the tropics has been settled by the fact
" that, for three centuries, the Spanish race has lived and thrived
" in tropical America." Mr. Crawfurd says:—" 'The question,
" 'whether the European race is capable of living and multiplying
" 'in a tropical or other hot region, seems to have been settled in
" 'the affirmative on a large scale in America. Of the pure Spanish
" 'race there are, at present, probably not fewer than six millions
" 'mostly within the tropics. But it is a wholly gratuitous
" 'assumption, unsupported by facts, to suppose that anything
" 'like this number of the Spanish race exist in America. If

* Waltz.

" 'we were to read for Mr. Crawfurd's 'millions' the word
" "thousands,' we should, perhaps, be nearer the truth. In
" 'Mexico, it is estimated that there are not more than ten
" 'thousand of the pure race, reckoning both Creoles and immi-
" 'grants.* What a small proportion is this to those who left
" 'their native land and have never returned again! For three
" 'hundred years Spain has poured out her richest blood on her
" 'American Colonies, almost at the price of her own extinction,
" 'without the slightest prospect of being able to establish a
" 'Spanish race in Central America. Never was there a greater
" 'failure than the attempt of the Spaniards to colonize tropical
" 'America. Those who have watched the gradual change of
" 'the Spanish Colonies must be convinced of the fallacy of
" 'quoting this as a case of successful colonization of tropical
" 'countries by Europeans. When the continual influx of new
" 'blood from Spain was taking place, the change was not so much
" 'observed; but now immigration has ceased, the pure Spanish
" 'race is diminishing rapidly. All recent observations shew
" 'that the Indian blood is again shewing out in a most remark-
" 'able manner. Instead of the Spaniards flourishing, there
" 'seems every prospect of their entire extinction, unless fresh
" 'blood is sent from Europe. The extinction of the Spanish race
" 'in America was likewise predicted, more than twenty years ago,
" 'by Dr. Knox. There is no doubt that this result has been
" 'greatly owing to the mixture of Spanish and Indian blood.' "

The evidences of the fact that the European race degenerates miserably in South America are overwhelmingly strong.

Many years ago, M. Pauw stated that the Creoles, descending from Europeans and born in America, though educated in the Universities of Mexico and Lima, and of College de Santa Fé, have never produced a single book. The Creoles, both of North and South America, he adds, come to a maturity of intellect, such as theirs is, more early than the children in Europe; but this anticipation of ripeness is short-lived in proportion to the unseasonableness of its appearance; for the Creole falls off as he approaches to puberty; his vivacity deserts him, his powers grow dull, he ceases to think at the very time that he might think to some purpose; hence it is commonly said of them that they are already blind at the time that other men begin to see.

* It has since been asserted, in the Cortes, by Don Pachero, that the pure Spanish race in Mexico does not amount to more than eight thousand. In 1793, Humboldt estimated the pure Spanish race, in New Spain, to consist of 1,200,000.

Dr. Waitz has accumulated a vast mass of proofs to the same effect. We shall quote some of his facts, omitting the references for the sake of brevity :—

'In the plains of Cordova and San Luis (Argentine Republic)
'the pure Spanish race predominates ; the young females are
'frequently of a white rose colour and delicate structure. Yet
'living in a state of isolation, the Spaniards have not exhibited
'greater activity and a stronger tendency to civilisation than the
'Aborigines of that country. The German and Scottish Colonies
'south of Buenos Ayres, with their flourishing and neat villages,
'form a decided contrast to the former. The white settlers
'south of Buenos Ayres are scarcely less rude and barbarous
'than the Indians. Criminals and the scum of all nations who
'take refuge among them instruct them in all that is wicked.
'Many cruelties and devastations are committed by these lawless
'men, over whom the Indian Chiefs have no authority. The
'Creoles of the La Plata States are almost as godless and dirty
'as the Indians. To construct windmills is beyond their mecha-
'nical talent, and, notwithstanding the great fertility of the soil,
'there is no garden to be seen on the high road from Buenos
'Ayres to Barranquitos. Except in the villages there is no
'cultivation of the soil. To catch lice is the chief amusement
'of the women, who offer them to strangers as dainties. They
'are dirty beyond measure ; they are even deficient in curiosity.
'A similar description is given of the inhabitants of Tucuman.
'The Indians of Rioja are simple-minded, sober men, whose
'disputes never lead to bloodshed ; they are more industrious
'and persevering than the Spanish Creoles, and their festivals
'never exhibit the same coarseness which distinguishes those of
'the Creoles. Many of the common utensils and tools of the
'Chilians, carts, looms, ploughs, are extremely clumsy, scarcely
'better than those of the Indians ; the axe is chiefly used, the saw
'but little. They are outdone by the superior agriculture of the
'Araucarians—they are very cleanly in their persons, they
'bathe several times daily, and by their cleanliness in the villages
'the Indians of the Tropics in America contrast with the
'immigrant South Europeans. In the vicinity of Talcahuano
'(Chili) D'Urville found such miserable dirty huts, that they
'could scarcely stand comparison with the habitations of the
'Polynesians. Helus, after describing the indolent habits of the
'Creoles of South America, adds, 'The Indians are the only
'industrious class in the country.' The colonists in the
'Llanos of Curracas are too lazy to dig a well, though they
'know that they could find the finest springs at the depth of

'ten feet. Even at this day there may be found in New Spain flou-
'rishing Indian villages and a well cultivated soil, near miserable
'villages of white Creoles. Ploughs are there in use made of
'wood without any iron, and are always drawn by oxen, never by
'horses ; and the Spanish Californians, whom Simpson has described
'as lazy and degraded, still avail themselves of a miserable plough
'and the canoe of the Indians. In Brazil the structure of bridges
'is neglected even on the high road from Rio Janeiro to Villa-
'Ricca, and agriculture is carried on according to the model of
'the Indians. The forest is burnt down : they sow, reap, and
'abandon the land after a few harvests. The Brazilian peasant,
'especially in the central and northern provinces of the Empire, is
'both lazy and proud ; he despises labour as dishonourable, he cares
'little for habitation and dress, suffering rather from heat and cold.
'His religious ideas, his belief in wood-spirits and other spectres, is
'as absurd as that of the Botocudes. The children of the Portuguese
'settled in the Sertajo grow up indolent and become prodigal ; their
'farms fall into decay. Ignorance and superstitious belief in
'witchcraft, spectres, and amulets are universal ; they have lost
'all the dignity of human nature, and only pass from their
'apathy to the grossest sensuality. Though pacific and hospita-
'ble, they are devoid of any intellectual or moral activity.
'Women and gambling form the sole objects of interest, and
'there are here some few Portuguese refugees who have for-
'gotten religion, the knowledge of the use of money, and even
'of salt.

'In Goyaz it is not much better ; the colonists are enervated
'by early excesses ; concubinage is so common amongst them
'that a married man is an object of mockery. Poverty is pre-
'valent ; their indolence is remarkable ; fraud, especially falsi-
'fication of the gold, is general. Something similar may be
'found in other mining and gold districts. The thirst for gold
'and labour is succeeded by wealth and prodigality ; then suc-
'ceed enervation, misery, poverty, and all vices. There has, for a
'long time, existed in the islands Fernando Noronha a Portu-
'guese criminal colony. No trace of agriculture is visible there,
'nor is any amelioration of their miserable condition thought of.
'The people smoke, gamble, or lie in their hammocks ; they
'have but a miserable ferry-boat, so that Webster exclaims in
'astonishment :—'Is it possible that these people are the
'progeny of the seafaring Portuguese, who were so eminent as
'navigators ?' In Africa the condition of the Portuguese is
'equally miserable. On the West Coast, where they settled in
'the sixteenth century, they have intermixed with the Negroes,

'and are pretty numerous; they live in forests; and it is their influence which obstructs the progress of the Siberia Republic among the Negroes. The indolence of the Portuguese on the east coast of Africa nearly equals that of the Negroes; their chief object is an existence which may be attained with the least possible effort. The horrors of their dominion and of their own degeneration are described by Omboni. In Angola, they have introduced no other agricultural implement but the hoe; and manioc, which affords but small nutriment, is still the chief vegetable aliment. The condition of the Europeans in the Banda Islands is but little better. Nearly all the Spanish and Portuguese Colonies rival each other in proving how little these nations are able to spread civilization in other regions; since, separated from their native country, they are not even capable of preserving the culture they have brought with them. The English and the French have, in this respect, proved more successful; but this superiority can only partly be ascribed to the superiority of the original stock, and to the care of the Government of their mother-countries to keep up the intercourse of the Colonies with the civilized world. Nevertheless we learn that, in the Mauritius for instance, the population of which is chiefly French, the condition of agriculture before the advent of the English (1810) was as bad as in the Spanish Colonies; ploughs were scarce, and the fields were not manured.'

Dr. Waitz adds:—'It may be objected that several of the instances cited referred to mixed populations and not to pure Europeans. Still it must be admitted that, even in these cases, the European blood, despite the improvement of the race which is usually ascribed to its infusion, has not proved its efficiency in raising the breed one step above the condition of the aborigines; and that even in such cases there was no intermixture, or a very slight one, the degeneracy of the population was nearly the same. The assertion that the European alone is capable of taking the initiative in civilization, and that the impulse thereunto is a peculiarity of the race, must, after the quoted facts, be considerably modified, for they prove, at least, that the white man is not much less dependent on external circumstances in his progress towards civilization than the black man. This is plainly shewn when we consider man in his individual capacity.'

In discussing this Spanish American Colonization question, it has always been considered that, in all probability owing to the strong interfusion of Moorish blood in Spain, the Spaniards,

like all the other dark Europeans, endure the heat of the tropics better than the white Europeans do. Colonel Flinter, long ago, observed that the Spanish soldier suffers less, and the British soldier more from the effects of the West India climate than those of any other nation. This, he considers, may be partly attributed to the climate of Spain being warmer than that of England. Judging by latitude, which, however, is not always a valid criterion, residence in Mexico ought not to be more trying to a native of Madeira than removal to Kamptee would be to a Sikh of Lahore.

In the present day, it is needless to devote much time to the argument that the increase of a mixed race in India would prove a failure both ethnologically and politically. Such races are never vigorous. Dr. Waitz shews that the half-breeds of Negroes, Indians, and Whites in Panama, are very prolific between each other, but cannot easily rear their children, whilst families of pure blood are less prolific, but bring their children up. The progeny of Chinese by Malay women in the East Indian Archipelago are said to die early. According to Dr. Yvan, the children of the Dutch and Malay women in Java are said to be only productive to the third generation. They are well developed up to the fifteenth year, when they remain stationary. In the third generation chiefly daughters are born, and these remain barren. It is also asserted that the children of Europeans in Batavia become frequently sterile in the second generation.

It was shewn in the *Calcutta Review* for September 1858, that,—while the respectable and provident portion of the East Indian community of Bengal are, at certain ages, subject to a less rate of mortality than that which prevails among any other class of Christians in India,—the mortality rate among members of the Uncovenanted Service Fund between the ages of twenty-six and fifty years was by no means favourable as compared with English rates, being 20·78 in the thousand. The mortality rate among East Indian ladies between the ages of fifteen and sixty-eight is higher, being 22·55 per mille.

The above facts and comparisons lead us to the conclusion that India comes fully within the category of those regions, which, permitting settlement, absolutely forbid colonization by Europeans. If it be considered a fact, proved on ethnological data, that it is physically impossible that our race should colonize India in the strict sense of the term, it, of course, becomes needless to waste time and argument in enquiring whether it would be either wise, humane, or profitable to attempt such a measure upon a national scale.

There can, however, be no doubt whatever that the extension of European *settlement* in India is one of the most interesting and important questions of the day. There is, undoubtedly, a great call for European settlers in India. And, with the assistance of native labour, abundance of profitable work lies before them in directing the clearance of jungle in Oudh and the Dhoon, in rearing cinchona trees on the slopes of the Himalayas and the Neilgherries, and in coffee and tea planting in Assam, Cachar, Darjeeling, and Kumaon. This measure, while it will tend vastly to confirm our power in India, will, strictly conducted, prove a large source of good to the natives of the soil, by the employment and agricultural teaching of multitudes of labourers, and by increasing the value of vast tracts of land which, at present, lie waste in the occupation of Zemindars. It is also to be borne in mind that the influence which is most inimical to the health of Europeans in India is the ill-distribution of trees and water throughout the country. Jungles and swamps are the main sources of Indian pestilences; the want of trees in the plains of Upper India, as barriers against the hot blasts from Sahara, was fully recognised and profitably remedied, for a time, by the ancient native rulers. By judicious clearing, planting, drainage, and irrigation, India may still be made what similar measures had rendered the lands of Babylon when Herodotus viewed them, the garden of the World, possessing a not disagreeable and tolerably healthy climate, in which European settlers may expect to lead industrious, pleasant, and happy lives in their plantations, sending their children home for education and re-invigoration, and calling them hither again, at full age, to become their successors in the land.

The men of England have been called to India by Divine mandate for many works, among which the systematic colonization of the country is not one. Industrially our mission here is to develop Indian enterprise, and to lay open the rich resources of the country. Morally, we are called upon to teach and civilize the people. To succeed as settlers in any land, we must first decipher from historic evidence those laws which the Father of All has legibly recorded for the governance of the dominant races when settling among rude and heathen people. The buccaneering settlers of ancient times neglected the true aims of colonization, and they reaped the fruit of their evil labours in disappointment and curses. We see Hernando Cortez in his progress towards Mexico, El Dorado acting like a magnet upon every sword-blade in his Company, coveting whatever he saw, grasping whatever he coveted,

exchanging collars of glass for armour and carkanets of beaten gold, burning the villages which refused to victual him, empowered only with the falsehood that to his master 'the monarchie of the universall did appertain,' and with the jibe that 'hee and his fellowes had a disease of the heart, whereunto gold was the best remedie.'*

About a hundred years later, we see Walter Raleigh going forth upon the same search for Mexican gold, professing, and probably with sterling truth, a desire to deliver the Indians from the tyranny of Spain, but ever intent upon 'the Star that directed him thither,—the great Guiana mine,' with utter disregard to the prior rights of the Spaniards, retorting upon those who accused him of piracy, 'Did you ever know of any who were pirates for millions? They only that wish for small things are pirates,' and, at the very last, encouraging his men with the cry, 'Come, my lads, do not despair. If the worst comes to the worst, there is the Plate Fleet to fall back upon!' Cortes sinks a heart-broken and disappointed man at the feet of the Monarch whom he served better than he served his God. Raleigh, beyond all comparison the noblest spirit of his time, ends that most brilliant and most disastrous career on a scaffold in Old Palace Yard, vainly attempting to prove to the gaping crowd that he had striven to live an honest man.

Certain lands have been, providentially, baited with gold, palm oil, diamonds, pearl-oysters, not that greedy men should flock thither, and, having filled their hands, their pockets, their chests, and their ships, return home to enjoy the profit or the plunder, but rather that, with the tide of trade, the wise, the pious, the educated, the largely humane should be attracted thither to spread among the people of the soil, whom their Father loves well, commerce, religion, civilization, agriculture, arts.

Thus England reads her duty in the present day, her religion and her policy alike teach her that the first principle of colonization and settlement is to render those subject nations for whom she legislates more virtuous, wiser, healthier, more prosperous, happier than they ever were before our standard was planted on their shores.

All revelation and all history combine in teaching us that the power of conquest and its inseparable attribute, the duty of civilization, are the Almighty's chief instruments in working out the moral and social advancement of mankind.

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* Purchas, his Pilgrimage.

From age to age these have, manifestly, wrought together. Wherever the angel with the drawn sword has sped forth, the angel with the open book has followed—at an appointed time. Our rulers know and act upon these principles, let us who throng hitherward with our swords, our learning, and our arts, be careful that we do not forget them.

INSTRUCTIONS

FOR THE

GUIDANCE OF SURGEON SUPERINTENDENTS

OF

GOVERNMENT EMIGRANT SHIPS

REGARDING

CONTAGIOUS FEVER,

AND THE

PRECAUTIONS WHICH SHOULD BE ADOPTED TO PREVENT ITS SPREAD.

BY

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1870.

INSTRUCTIONS.

History of the disease.

Of late years a fever, remarkable both in its symptoms and in the great fatality with which it is attended, has attracted much attention in India. From about the close of the year 1859 there are records of very severe epidemics of this disease, occurring either among the general population, among prisoners, or among emigrants and others on board-ship. There is no reason to suppose that this fever is a disease of such recent date in this country, but of late years the information regarding it is more precise.

Great mortality it has occasioned in jails.

Of the epidemics which have occurred among the general population, no very definite particulars are known, but it is a well-ascertained fact that this disease has prevailed among the people at large, and that it has been the cause of much mortality amongst them. Of its effects amongst prisoners in Upper India, there is very sufficient evidence. Many jails have suffered from it most severely, and the deaths among the jail population which have been due to it during the last ten years number at least 6,500. The statistics of some of these epidemics are both interesting and instructive.

STATEMENT showing the results of the chief outbreaks of Contagious Fever that have occurred since 1860.

Year.	Jail.	Strength of Prisoners.	Number of Deaths.		
			Contagious Fever.	Sequelæ.	
				Dysentery.	Atrophy.
1860.	Lucknow	663	156	45	......
	Allahabad	1,595	119	93	10
	Agra	1,890	244	109	58
	Mynpoorie	159	10	3	......
	Bareilly	690	10	31	13
	Meerut	2,098	220	128	60
1861.	Allyghur	336	73	21	......
	Meerut	2,189	429	343	71
	Delhi	423	20	16	5
	Thanesur	477	52	92	......
	Umballa	704	151	44	4
	Loodianah	114	33	11	......
	Jullundur	618	82	29	12
1862.	Agra	2,209	51	......	13
	Allyghur	246	52	......	......
	Bareilly	1,768	253	64	7
	Meerut	1,342	61	65	7
	Delhi	424	17	23	......
	Umballa	539	92	9	1
	Loodianah	204	57	13	1
	Jullundur	303	68	20	1
	Lahore	2,109	24	......	8
	Rawul Pindee ...	764	25	8	1
1863.	Agra	2,158	141	31	12
	Allyghur	209	31	3	......
	Bareilly	1,323	134	25	......
	Budaon	253	14	3	......
	Lahore	2,027	196	......	33
	Sealkote	220	17	......	......
	Rawul Pindee ...	682	49	......	15
1864.	Futtehghur	404	55	......	......
	Agra	1,993	346	......	18
	Delhi	299	24	......	......
	Umballa	866	158	55	24
	Umritsur	554	51	10	......
	Lahore	1,644	144	11	......
	Goojranwalla	330	26	21	......
	Mooltan	653	52	......	3
	Rawul Pindee ...	763	37	10	4
1865.	Nagpore	790	54	43	......
	Jubbulpore	407	36	......	......
	Bareilly	1,697	52	......	......
	Sirsa	257	16	......	......
	Umritsur	535	28	......	......
	Lahore	1,964	74	......	......
	Goojrat	259	17	......	......
	Peshawur	358	34	20	......
1866.	Gondah	951	54	11	......
	Baraich	158	19	......	......
	Sultanpore	227	19	......	......
	Lucknow	2,619	233	......	......
	Allahabad	2,403	37	......	......
	Umballa	698	48	......	......
1867.	Gondah	836	29	......	......
	Peshawur	406	32	......	......
1868.	Gondah	568	81	......	......

Great loss of life from it on board emigrant and other ships.

On board-ship it has also appeared and has proved very fatal. Quite recently it broke out among bearers proceeding on service to Abyssinia, and among others returning from that expedition. Among the muleteers of the force coming back to their homes in the Punjab, it was very severe. Out of a strength of about 5,000 men, more than 400 died of the disease. In the years 1864 and 1865, it appeared in certain emigrant ships sailing from Calcutta, and very many of the emigrants died. The particulars are given in the following statement :—

Name of Ship.	Date of departure.	Date of arrival.	Number of days at sea.	Number of souls embarked.	Number of deaths on the voyage.	Number of deaths after arrival.	Total number of deaths.	Percentage of deaths to strength.
		To Demerara.						
"Athletæ" ...	18th November 1864	15th February 1865	89	439	36	63	99	22·55
"Clarence" ...	19th December ,,	5th March ,,	76	515	122	14	136	26·40
"Earl Russell" ...	13th January 1865	12th April ,,	88	431	93	...	93	21·57
"Golden South" ...	5th February ,,	26th May ,,	109	434	124	9	133	30·60
"Ganges" ...	26th ,, ,,	28th June ,,	122	398	147	14	161	40·40
"Fusilier" ...	15th March ,,	25th May ,, Wrecked at Natal.	72	491	160	86	246	50·30
		To Trinidad.						
"Newcastle" ...	28th January ,,	29th April 1865	91	538	15	38	53	9·90

It will be seen, that on board one vessel more than one-half of the emigrants died, and the total number of deaths in the seven ships, occurring either during the voyage or immediately after it, amounted to 921.

This excessive mortality was, by order of the Secretary of State, made the subject of a special enquiry, and the enquiry was carried out by the Sanitary Commission. The conclusions at which they arrived were chiefly these :—

Special enquiry into the mortality in these ships.

1*st*.—That the disease, which had caused the lamentable loss of life, was a fever in all respects similar, if not identical with that which had proved so fatal to prisoners in the Upper Provinces of India.

2*nd*.—That it had been introduced on board at the time of sailing by some person or persons already suffering from it, or having the seeds of it already within him.

3*rd*.—That the first case or cases not having been recognized, the disease spread with great rapidity in virtue of its contagious nature, and the very favorable circumstances which must exist on board-ship for its dissemination.

The Sanitary Commission were unanimous in arriving at these conclusions. The evidence in support of them was strong, and in some respects very remarkable, but the opinions which they expressed were opposed by other authorities. It was said that the disease was not imported on board these ships, but that it originated there in consequence of over-crowding. There were certain circumstances which at first sight favored this view of the case; but as the settlement of this question, however interesting and important, does not affect the practical object of this memorandum, the different arguments in favor of each explanation of what occurred need not be discussed.

Difference of opinion as to the origin of the fever.

Whether taken on board or bred on board, the disease may again appear among emigrants on board-ship, and cause a mortality as lamentable as it did in 1864-65, unless timely precautions are adopted to arrest its spread. As the Sanitary Commission remarked—"It is of the utmost consequence that measures should be devised for meeting such a danger. The first point of importance is, that the Surgeon Superintendents of vessels should be acquainted with the disease; that they should have before them the possibility of its occurrence, and should ever be on the watch for its appearance." With this view it was suggested, that a short account of its symptoms and treatment, and of the measures which ought to be adopted in such circumstances, should be prepared, and that each Surgeon Superintendent should be provided with a copy. In accordance with this suggestion, and with the orders of the Government directing that it should be carried into effect, this short memorandum has been written.

This does not affect the management of the disease once it appears on board-ship.

As one case of the disease may prove the centre of an epidemic and occasion the loss of many lives, it is of the greatest moment that the disease should be immediately recognized, and measures at once taken to prevent its spread. What then are its symptoms? It may shortly be described as a fever ushered in with rapid and extreme muscular depression, frequently attended with jaundice, with vomiting and hæmorrhagic discharges from the nose or bowels (the vomiting in some cases appearing to be of a character similar to that which attends on yellow fever), marked by a decided proneness to relapse, and a great tendency to death, which usually takes place in the fatal cases about the 5th or 9th day. It is necessary that the symptoms should be more fully detailed, and the excellent descriptions of the disease given by Dr. W. Walker, who was in charge

Symptoms of the disease.

of the Agra Central Prison during the epidemic of 1860, and by Dr. Gray, who was Superintendent of the Lahore Central Jail during the latter part of the outbreak of 1863, are here extracted :—

Dr. Walker's description of it as it appeared in the Agra Central Prison in 1860.

" *General symptoms.*—Two-thirds of the men coming under treatment asserted that their illness commenced with a shivering fit. While inclined to accede to this statement, in so far as the occurrence of the ague fit is concerned, I have good reason to believe that in most cases a previous period of malaise was passed through, either unobserved by the men themselves, or (when the disease became so fatal) concealed by them, to avoid their being sent to hospital. Besides the evidence on this head gathered from the lumbardars of the barracks and gangs, the rapidity with which great bodily weakness supervened points to a period during which the fever-poison had been lurking in the system and depressing the vital energies. When the attack came on during the night, the men were hardly able to walk to hospital in the morning, and never able to carry their own bedding. The expression of their faces rapidly altered; they looked wearied, listless and unconcerned, and they were already possessed with the idea that they would never recover from the disease. In strong men the countenance at first was full and flushed, the veins protruding from the forehead, and the eyes were suffused, or even bloodshot. Head-ache was by no means a constant symptom, but when present, was always complained of across the forehead. Pains in the back and limbs were constant and severe. The skin was hot, dry, and pungent; the pulse at first full and bounding, and varying from 110 to 130 in frequency. The tongue, after a few hours, became covered in the centre with a dry white fur, the edges and tip becoming bright red. In a few cases it remained dry and glazed, but without fur throughout the attack, acquiring a dark brown line down the centre as the disease advanced, and becoming a little furred on the approach of convalescence. Vomiting occurred in the early stages in many cases; very often the belly was or became tense and swollen, with

Early muscular depression.

Physical expression.

Head symptoms.

Skin.
Pulse.
State of tongue.

Vomiting.

considerable tenderness on pressure in the epigastrium. The bowels were mostly constipated, but a slight purgative was often sufficient to set up uncontrollable diarrhœa. The urine was scanty and very high colored, passed with considerable difficulty, and very often completely retained. Throughout the epidemic, the respiratory organs were much affected, mostly so, however, at its commencement, *viz.*, in the beginning of March. At the time, scarcely a case came into hospital without exhibiting this complication most violently. The labored quickness of respiration, and the fine rhonchus disclosed by the stethoscope, showed, even in the absence of cough and sputa, to what extent congestion had advanced.

Condition of bowels.

Condition of respiratory organs.

" *Muscular depression.*—The nervous centres rarely became affected for the first three or four days, but the muscular depression increased hourly. The men lay on their backs with out-stretched limbs, unwilling or unable to move. The hand when raised, shook, and could with difficulty, be directed to the wished-for position; the tongue was protruded tremulously, and with apparent effort. By-and-by the functions of the brain begin to be impaired. The patient lies dosing uneasily, his eyelids are closed, but he does not sleep: if you forcibly open them he complains, and turns his head from the light, and you can see that his pupils are fixed, sometimes contracted, sometimes dilated. At a still later period, you require to shake him, and speak sharply to attract his attention; but even then he would answer you rationally, only he is unwilling to be disturbed, and lapses again into the same dosing state. About the fifth day he gets rapidly worse; he is incapable of the slightest muscular exertion, and slips down off his bedding on to the centre pathway of the hospital; his pulse from being pretty full becomes hourly smaller, weaker, and more rapid; sordes collect about his teeth and gums; his tongue becomes dry and baked; the fur browns and cracks, but does not thicken much; his throat is so parched that he is made to swallow with the greatest difficulty; he loses his voice, and speaks only in a whisper; he complains of no pain. Gradually low muttering delirium supervenes; he becomes insensible to all surrounding objects, and cannot

State of nervous centres.

Condition of pupils.

Occurrence of sordes.

Fatal termination.

be roused; he passes his stools and urine involuntarily, and dies comatose.

"The above is a rough sketch of the course which the majority of the fatal cases ran. With the few exceptions of men who died within 48 hours after admission into hospital, the crisis of the disease occurred on the fifth, seventh, or ninth day. At those periods the patient's system was either overpowered by the blood-poison, and he died comatose, or the fever left him, and he became convalescent. Usually there was no very marked crisis. Sometimes there was an increased flow of urine, less frequently a profuse perspiration, but almost always an increased discharge from the bowels. Neither the patient nor his attendants could tell exactly at what time the fever left him. Within a couple of hours his skin became soft and slightly moist, from being hard, dry, and pungent; his pulse lowered in rapidity and became soft; his tongue and mouth moistened; he complained less of thirst and of dryness of throat; his countenance, in a few hours, was quite altered; instead of the restless twitching irritability of his roused condition, and the dull, listless quiet in which he lay when undisturbed, his face became quite relaxed and placid; his eyes were opened and tolerant of light; he lay on his back equally helpless as before, but beyond weakness, and a feeling of being bruised all over, he declared himself well.

Time of critical period.

Symptoms marking the crisis.

Gradual resolution of febrile state.

"*Frequent occurrence of relapses.*—Often the cases now went on well, and the men acquired strength day by day; but in a large proportion, after the third or fourth day of convalescence, a change occurred. This resulted sometimes, no doubt, from indiscretion on the part of the patient, but more probably from the imperfect elimination of the morbific matter from the blood. All the former symptoms returned with increased violence. The tongue, which had been moistened, gradually cleaning, becomes again dry and fissured, fur collects and thickens, and a brown crust forms rapidly. All the typhoid symptoms are intensified; the dry pungent heat of the skin; the small, quick, thready pulse; the restless, semi-delirious wakefulness; and, finally, the cold clammy sweat that ushers in the quiet of coma supervenes.

Typhoid symptoms intensified in relapse.

"*Fatal termination of relapse most commonly by dysentery.*—If the patient lived over forty-eight hours of the relapse, nature seemed to make an effort to throw off the blood-poison by a profuse discharge from the bowels. At first the patient passed large quantities of dark, gravelly-looking fœces, with a most offensive odour, but this rapidly changed to shreds of mucus, mixed with slime, and streaked with blood, and often to pure blood. Although several cases rallied on the occurrence of this discharge, they generally perished from the subsequent chronic dysentery.

"*Cases exhibiting peculiar features.*—Four or five cases exhibited features so distinct from any detailed above that they demand separate notice. With them, after the fever had lasted from twenty-four to forty-eight hours, all the symptoms seemed to subside; the patient's skin became quite cool; his pulse quiet and soft; his breathing easy and natural; he lay on his back, but complained of nothing, and only his unnatural quiet condition attracted attention. His eyelids remained closed, but the eye had no intolerance of light; the pupils were sometimes contracted, at other times dilated; he could answer questions when roused, but did so very unwillingly. The patient usually lay in this state for three or four days without tasting food, and at last passed quietly from sleep into death. The *post-mortem* examinations in those cases revealed a serous effusion to great extent in the ventricles and under the pia mater of the brain.

Symptoms.

Result.

Post-mortem conditions.

"*Cases of extremely rapid fatality.*—In a few cases the disease was so rapidly fatal that the men passed at once into a state of coma. The blood-poison seemed instantaneously to overpower the nervous system. These extreme cases were seen most frequently in the hospital attendants, strong, vigorous men, but who were of necessity much exposed to contagion. The attack in this form was often ushered in by intense nausea and retching, but none of the patients complained of pain on pressure in the epigastrium, indicating that the origin of the vomiting lay in the cerebrum. Nine men died within 24 hours, and fourteen died within 48 hours, of their coming under observation.

"Before passing on to consider a few of the sequelæ of the disease, I may advert here to an observation having reference to the sequence in which the prime characteristic of the epidemic, namely, congestions of the internal viscera, occurred.

Sequence of internal congestions.

In the end of February and during the early half of March, my attention was chiefly attracted to the respiratory organs; all the symptoms pointed to the lungs as being deeply involved in mischief, and the stethoscope gave no uncertain indications. Wheezing and hissing sounds were to be heard over the chest, and the *post-mortem* examinations, as will be seen, sustained the diagnosis. Although at no period of the epidemic were the lungs free from congestion, it was evident that at first the tendency to death was by apnœa. Taking into consideration that at that time the mean daily range of temperature was 36°4′, the prominence of the lung affection is scarcely to be wondered at."

Lung congestions.

Range of temperature the probable cause.

* * * * *

"*Swellings of parotid gland.*—Swelling of the parotid gland on one or both sides occurred so often at the crisis of the fever as to form a characteristic feature of the epidemic; 26 marked cases came under my observation, and many other patients complained of pains and stiffness in the parotid region, of whom I took no note. Of the 26 cases, ten resulted in suppuration; in the others the swelling gradually resolved itself under remedial measures. Erysipelas of the head followed these swellings in four cases, two of which proved fatal; while two of the cases in which suppuration occurred died of the exhaustion consequent on the profuse discharge. As I shall have to refer to the point again, I shall not now do more than indicate this as one link of connection between the fever we are now describing and the typhoid fever of Europe."

* * * * *

"*Contagious nature of the fever.*—That this fever did possess the property of contagion in an eminent degree rests on the most indubitable evidence."

* * * * *

"*Period of incubation.*—The period of incubation, before the disease developed itself, was from 15 to 19 days, or, at all events, the men labored in the hospital up to that time and then fell ill."

Dr. Gray thus describes the fever :—

Dr. Gray's description of it as it appeared in the Lahore Central Prison in 1863.

"The patient, when admitted into hospital generally entertained the most gloomy apprehensions as to his condition, anxiety being evidently depicted on his countenance. When asked as to the seat of pain, he would sometimes refer to his loins, limbs and head; but more frequently he would state that his internal organs, liver, kidneys, &c., were rotten or burnt up. With regard to the existence of premonitory symptoms, some admitted that they had felt more or less ill in the barracks for two or three days, and that at a stated time, a distinct shivering fit had occurred; others, however, affirmed that only a few hours ago they had become suddenly warm and feverish, their head giddy, &c., but that no premonitory symptoms or shivering had been experienced.

Symptoms on admission.

Premonitory symptoms.

Physiognomy.

"The countenance, presenting an anxious but usually not a dull or stupid expression, was in many cases covered with a more or less general flush; the conjunctivæ, as a rule, were not greatly, if at all, congested, but the very generally jaundiced tinge was most observable: this tinge in a great number of instances became developed into a deep yellow hue. The tongue was deeply yellow or white furred, and very often even on admission had already dried at the tip; if it had not, in bad cases a triangular piece at the tip soon became dry and brown, the process extending backwards at first along the centre. Instead of the furred tongue, there were not a few instances in which it became dry, glazed, and shining; there was usually very intense heat of skin, which was also dry. I very carefully looked for a rash, but none was ever discovered to exist. The pulse was usually at first full and frequent, 100-120; it soon became weak and compressible, retaining its frequency. Thirst was a most constant symptom. The respiratory movements were generally quickened in proportion to the state of the pulse.

Tongue.

Skin.

Thirst.

Respiratory movements.

State of nervous and muscular systems.

"There was usually from the first very great muscular and nervous depression; the patient was quite conscious, but did not wish to be disturbed; often there was frontal head-ache or vertigo, the prisoner stating that on attempting to lift his head, it appeared to whirl round; the tongue was frequently protruded in a series of tremulous jerks, and the arm when raised trembled like an aspen leaf. In very few cases was there impairment of the mental faculties, at least till towards the termination of the disease.

Vomiting.

Gurgling on pressure over the epigastrium.

"Vomiting was not unfrequent. In some instances it was severe, but, as a rule, it was not persistent; when it did occur, it was at the commencement of the disease. There was often more or less gurgling on pressure over the epigastrium; pain was also generally felt there on pressure, though not complained of before.

Enlargement of liver and spleen.

State of bowels.

"Enlargement of the liver and spleen was most frequent. The bowels were usually constipated, but great care had to be taken in the medicine used as aperient, diarrhœa being most liable to supervene.

State of urine.

"The urine was scanty and high colored, the patient supposing that it was mixed with blood.

"The above is a general outline of the symptoms as observed on the patient's admission. They did not, of course, all present themselves in each case, and when present, they varied considerably in severity, but there were numerous admissions, which in every particular corresponded with the account given.

Progress of cases that proved fatal from fourth to seventh day.

"The majority of the fatal cases that did not succumb from some sequela were protracted till the fourth, fifth, sixth or seventh day. In these, the severity of the symptoms described became aggravated: the tongue from being white or yellow-furred became dry and brown, sometimes quite black and deeply cracked; the pungent heat of skin remained; the pulse soon lost its fulness, becoming weak and thready; prostration increased; sordes collected about the teeth and lips;

the patient would in all probability become torpid, but retain his senses till within a few hours of death, when the torpor sometimes passed into a state of coma, under which he would sink.

State of coma or insensibility short when it occurred.

"It is worthy of remark that the last mentioned stage, *viz.*, that of coma or insensibility, when it did exist, was not, as a rule, protracted. Often did I examine and receive rational answers from a patient in the evening, who, I was informed on my visit to the hospital next morning, had become insensible during the night and died.

Cases that proved rapidly fatal.

"Not a few died under one, two, or three days after admission into hospital. These were the cases that exhibited the greatest sense of weight and oppression, and my opinion is, that the virulence and strength of the fever-poison paralysed the ganglionic system of nerves, thus stopping the action of the secretory and excretory organs, and bringing on death by collapse. The proportion of such rapidly fatal cases was less after I took over charge, than it was in the two or three previous months.

Progress of cases that did not prove fatal within seven or eight days after admission.

Continuance of symptoms for five to nine days.

Cessation of symptoms.

Crisis.

"In cases that did not prove fatal in either of the ways above described, the original symptoms remained unabated for a period varying from five to nine days, (the average being six or seven.) During the twenty-four hours, and from day to day, there was no distinct remission in the febrile symptoms. After the second or third day the tongue usually became dry, and in many instances brownish; the pulse smaller and weaker; the patient perfectly sensible complained of distressing thirst, and the pains in his bones and joints; at the end of the above-mentioned period (five to nine days), there was a sudden cessation of the febrile symptoms, the crisis being in a good many instances ushered in by profuse perspiration, but much more frequently by a discharge of copious watery stools. The pulse became slow, the tongue moist, and the skin lost its pungent heat and great dryness. With the exception of a general feeling of weakness and pains in the limbs, joints, or muscles, the patient now expressed himself well, and if his appetite had gone, which was not invariably the case, it returned, and he was clamourous for food. In this state of apparent convalescence he would remain for several days (from four to eight or nine), when all the original symptoms presented themselves and continued sometimes for about the same number of days as the original attack, but generally the period of duration was shorter. The adynamic tendencies before described were observable in the relapse, and many succumbed to it.

Apparent convalescence.

Relapse.

Adynamic tendencies manifested during the relapse.

"In not a few instances a second interval of complete quiescence was followed by a second relapse, and a third or even fourth recurrence of the sequence was not unknown.

Second, third, and fourth relapses.

"The occurrence of relapses was universally noted by the prisoners themselves, who divided their illness into periods which they denominated as their first, second, &c., attack.

Relapses noted by the prisoners.

"Dr. Penny in his sanitary report points out the same circumstance relative to relapses. He says:—'In the cases of recovery, almost without exception, was there a relapse. It became the rule for a second attack to occur, and it was exceedingly common for the Native Doctor to report that it was the third or even fourth time of recurrence.'

Dr. Penny's account of relapse.

"At first I administered quinine largely, with the hope of being able to ward off the relapse, but it had no apparent effect, the relapse occurred seemingly with as great regularity as if the specific had not been exhibited.

Relapses not warded off by quinine.

"The absence, therefore, of remissions in the fever, the definite course it pursued, the occurrence of distinct critical periods, followed by a disappearance of the febrile symptoms, all tended to produce the conviction in my mind that the fever, however it may have originated, was now (in February) of a continued type, and attributable not to a malarious, but an animal poison.

"It is well known that in former times typhus fever was the scourge of jails, both in England and on the Continent. I had little difficulty in coming to the conclusion that typhus was not the type of fever generally prevalent.

The type of fever. Was it typhus?

"Dr. Penny states that up to 1st January 1864, out of 1,527 cases treated there were only 7 in which head symptoms occurred. In my experience head symptoms were considerably more frequent, but they were so common as to negative decisively the idea that the fever, as it generally occurred, was typhus. The few instances of delirium were quite masked by the large proportion of cases in which the men retained perfect consciousness during the whole course of the disease. When delirium did occur, it was of the low muttering form characteristic of typhus, and I am inclined to believe that there was an admixture, though a small one, of typhus cases.

Number of cases in which Dr. Penny observed head symptoms.

"It will be asked, was it typhoid or enteric fever? I am convinced it was not. As stated before, the disease tended rapidly to put on a low adynamic form, and it was not uncommon for the collection of symptoms known as 'typhoid' to present themselves. But it is well known that the typhoid state may come on in numerous other diseases, besides typhoid fever, *e. g.*, in pneumonia, typhus, remittent fever, or even after severe accidents or amputations. The mere occurrence, therefore, of typhoid symptoms did not warrant me to draw the conclusion that the fever was that usually designated enteric or typhoid. Other evidence was wanting.

Was it typhoid or enteric fever?

The occasional supervention of typhoid symptoms no proof that it was typhoid or enteric fever.

"I had numerous opportunities of making *post-mortem* examinations, and I carefully inspected the intestines with the view of determining the point in question; but in not a single instance did I discover ulceration of the agminated patches of Peyer, which is confessedly one of the most constant and characteristic appearances found on *post-mortem* examination after typhoid or enteric fever.

Result of *post-mortem* appearances negative the idea that it was typhoid or enteric fever.

"The solitary glands of the large intestines were not unfrequently ulcerated, and it was not unusual to find congestion of the small as well as large intestines; but these results might have been anticipated, as dysentery and diarrhœa were two of the most common sequelæ."

Treatment of the disease.

As regards the treatment, Dr. Gray's experience may also be quoted, but it is to be observed, that there is no special remedy which appears to have any beneficial effect, and that the ratio of deaths is very high.

Remarks by Dr. Gray.

Treatment of the disease.

Quinine of no avail during the febrile stage, or in preventing relapses.

"So far as my experience of the late fever goes, no remedial measures cured or cut short the disease. I soon became convinced that so long as the febrile stage lasted, no benefit resulted from the exhibition of quinine, and I have previously recorded my opinion that it was apparently powerless in preventing the occurrence of relapses. Certainly, during the period of convalescence, I very generally exhibited quinine as a tonic; but other tonics I looked upon as equally efficacious, *e. g.*, the dilute mineral acids and preparations of iron, especially the common tincture of the muriate of iron.

"The objects aimed at latterly were to assist nature in eliminating the poison from the system, to meet complications as they might arise, and to support the powers of the patient, so soon as it might be necessary, by generous diet and stimulants.

Treatment adopted on admission.

"The constipated state of the bowels on admission was generally relieved by the exhibition of two or three grains of calomel or pil. hydrarg., as many of extract. colocynth. co., and a grain of pulv. ipecac., followed in three or four hours by a warm rhubarb draught. In cases presenting an unusually jaundiced tinge, the constipated state of the bowels was generally more obstinate than when that symptom was absent, and in those cases the same dose had to be administered a second or third time before the bowels were freely opened.

Treatment during the febrile stage.

"During the febrile stage, when there was great heat and dryness of skin, liq. ammon. acetatis with potassæ nitras was generally exhibited; but even profuse perspiration when it occurred was not necessarily followed by any amelioration of the severity of the symptoms. The free use of a drink of dilute acetic or sulphuric acid was very grateful, and considerable relief was expressed to follow sponging the surface of the body with tepid water and vinegar. In cases where the tongue was thickly white or yellow-furred, a powder of two or three grains of hydrarg. c. creta, as many of pulv. antimon. co. with from six to eight of potassæ nitras, was often given, and thought to be beneficial in acting on the liver, &c.

Minimum amount of lowering treatment borne.

"When local inflammation or congestion took place, the nature of the disease admitted only of the minimum amount of lowering treatment. In bronchitis and pneumonia, even local bleeding was scarcely ever resorted to, or if it was, the quantity of blood abstracted was very small; counter irritation by means of sinapisms, blisters, &c., was freely applied in cases exhibiting both lung and liver complications, and in the instance of enlargement of the latter organ attended by jaundice. The only medicine from which I think benefit was derived was a mixture of the dilute nitro-muriatic acid with nitre. I have no doubt that those medicines acted beneficially after the bowels were opened by the doses already described, as generally administered on admission.

Treatment of diarrhœa and dysentery.

"Diarrhœa and dysentery were often most obstinately persistent and defied all treatment, the medicines that usually prove efficacious in those diseases being but too frequently powerless to do anything else than produce a slight and temporary improvement.

Treatment of dysentery when occurring as a sequela.

"The combination of gallic acid and dilute sulphuric acid and opium, I found perhaps more beneficial in the diarrhœa cases than any other medicines, and under its use some very bad cases pulled through. In chronic dysentery cases, ipecacuanha in three or four grain doses, with and without opium, and hydrarg. c. creta, was frequently tried and found to be perhaps more efficacious than any other remedy; but this as well as every form of astringent, whether given by the mouth or in the form of enema, too often proved of no avail. The treatment might, with stimulants and generous diet, keep the patient alive till he was little else than a mere skeleton, but the proportion of cases that recovered from this form of sequela when fully developed was very small indeed.

"The powers of the patient had often to be steadily supported almost from the first. Diffusible stimulants and spirits were freely administered; and had it not been that they were freely supplied, and the extra diet dispensed with a liberal hand, the mortality, great as it has been, would, I have no doubt, have been very considerably increased. All the sick were fed regularly three or four times a day, sago, arrowroot, soojee, milk, dhaee, and meat made into soup, forming the principal articles of the extra diet, such of them being given as were considered most suited to each particular case."

Obscurity of the symptoms in some cases.

In some cases it must be remembered that the symptoms are very obscure, and that the true nature of the disease is apt to be masked by the serious complications with which it is accompanied. Many cases have been regarded as "jaundice," others as "fever with diarrhœa," or "fever with dysentery," others, again, as merely "bilious remittent fever," or from the great tenderness over the epigastrium, which is a prominent symptom, the patient has been thought to be suffering from "hepatitis." In some instances, the cases have been mistaken for "rheumatism," and in others for "pericarditis." With so many sources of error and such a danger of mistaking the true nature of the disease, it is of all the more consequence that the medical officer should be prepared and on his guard.

Name of the disease.

Much discussion has taken place as to the name by which this fever should be called. By some it is considered to be relapsing or famine fever; by others, it is called a "typhoid remittent;"

by others, again, it is supposed to be more nearly allied to yellow fever than to any other disease. Although it bears a striking resemblance to "relapsing fever," it differs in the much greater fatality with which it is attended, and it presents a still more remarkable difference in this respect, that it has never specially attacked the people suffering from the effects of famine. In Rajpootana, for example, during the present year, when the population have been enduring the miseries of famine, and diseases consequent on insufficient nourishment have been common, this fever has not appeared. Its epidemic appearance in the North-West Provinces preceded, and did not follow, the great famine of 1861. But of whatever scientific interest it may be to give the disease its proper name, the correct nomenclature is of no practical importance; it will assist neither in explaining its origin nor in determining its treatment. On the other hand, much evil has resulted from attaching undue importance to the nomenclature of the disease, and it has happened that authorities have been discussing the name of the fever when their whole energies should have been devoted to the practical measures for arresting its spread. The point of practical importance is, to remember that the fever is highly and insidiously contagious, and that its danger, especially within confined limits, as in a jail, and still more on board a ship, lies in this contagious nature.

Importance of preventive measures.

Much more important than the name of the disease, or even than its cure, is its prevention. It will be observed that there is nothing to the inexperienced eye which denotes any special danger, but any one who has seen an epidemic of this fever learns to appreciate the full meaning of the marked depression, the jaundice tinge, and the other concomitant symptoms which have been described.

The practical question then remains, in the event of one or more cases of this fever appearing, what precautions should be adopted. The following rules should be observed :—

What precautionary measures should be adopted.

1st.—If the case be even suspicious, the patient should be at once isolated in an airy position.

2nd.—The portion of the ship which he occupied should be thoroughly cleansed and disinfected.

3rd.—Special attendants should be selected to wait on him, and by the use of disinfectants and other means, every precaution should be taken to prevent their being affected. Plenty of fresh air is essential around the sick man, and this indeed is the most perfect protection for those who are necessarily brought in contact with him.

4th.—The attendants should not be allowed to mix with the other emigrants or passengers.

5th.—If other cases occur, they should be similarly dealt with.

6th.—On the recovery or death of any persons suffering from the disease, their clothes or any other articles likely to contain the poison, should, without fail, be thrown overboard.

7th.—If, in spite of all precautions, the disease spreads, the nearest port should be made for and the emigrants disembarked.

8th.—After disembarkation, the sick should be kept isolated, and every precaution taken to prevent the spread of the disease among the population of the place in which they have been landed.

It must be remembered that both at Réunion and at Mauritius there is reason to believe that for want of such preventive measures, a wide-spread epidemic has been produced among the inhabitants.

Simla; the 25th October 1869.

THE BREAKDOWN

OF

YOUNG SOLDIERS UNDER TRAINING

EXPLAINED:

BY

SURGEON-MAJOR F. ARTHUR DAVY, M.D.

WOOLWICH:
PRINTED BY F. J. CATTERMOLE, 20 & 21, ARTILLERY PLACE.
1883.

PREFACE.

I have been led to print, for private circulation, the three papers contained in this pamphlet in consequence of the difficulty of late experienced in obtaining recruits for the Army.

The perusal of General Sir Lintorn Simmons' paper in the July number of the "Nineteenth Century" will convince anybody that our first concern should be to seek for the causes of the waste of the Army, which he aptly likens to pouring water on a sieve. Men join, and within ten or twelve months are gone again in enormous numbers. This points, as far as desertion is concerned, to discontent with the life they have recently chosen.

The papers that follow are printed in order to draw attention to one special cause of discontent, and not only of discontent, but of disease: a cause of which the sufferers themselves are ignorant. I allude to the training to which young

ERRATA.

Page 30, line 22 from bottom—for beneficient, read beneficent.

Page 32, line 15 from top—for excercise, read exercise.

waste by saying—

"The general result for the whole army is that out of 186,469 men who "enlisted during eight years, 47,648, or one-fourth, had disappeared before the "end of the year succeeding that in which they enlisted; and 54,993 before the "end of the second year, with an average of little more than ten months' "service. These men had cost the country the enormous sum of £3,150,000, "without yielding any return, the whole sum having been entirely wasted. "After making due allowance for death and disease, and for dismissal for "misconduct, it is clear that 45,000 fewer recruits would have been required "during these eight years to keep the Army up to its strength: and if waste at "subsequent periods of service were included, it could be conclusively proved "that from 7,000 to 8,000 fewer recruits would be required annually, if only the "men were contented, and remained in the Service during the periods for which "they engage to serve. As the actual number of recruits enlisted below 19 "years of age during the last 9 years has been only 58,898, it is evident that if "this costly and useless waste could have been prevented, it would not have "been necessary to enlist any of these youths, and the army would still have "been complete to its establishment. This is a clear and definite answer to "those who say we cannot keep the Army full without enlisting boys."

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The papers that follow are printed in order to draw attention to one special cause of discontent, and not only of discontent, but of disease: a cause of which the sufferers themselves are ignorant. I allude to the training to which young soldiers are subjected: a training presumed, and believed by the men to be a perfect system; but which is, nevertheless, a false and a disease-producing system.

It may seem bold to say this: and many, if they read so far, may think that it will be scarcely worth while to read further. They might grant me that no system is altogether perfect, and that as improvement in everything is progressive, so with recruit-training; but they cannot assent to the doctrine that radical defects exist, that have long been overlooked, in our training of recruits. Such persons will but read this preface.

Still, it is best to be candid, and to say that the contention of these papers is that we have been injuring the men we would benefit, and invaliding thousands who, under a proper system of training, would have well served the State. A few will read these papers to the end. To those who content themselves with the preface I would say that some very special reasons should be assigned to account for a discontent, among recently-enlisted men, represented by such figures as those given by Sir Lintorn Simmons, from whose paper I quote the following paragraphs. After giving in detail the figures representing the waste of the Army in its different branches, and the cost to the State of that waste: and after stating that these figures are obtained from the published returns "which cannot be repudiated by the Authorities," Sir L. Simmons sums up the waste by saying—

"The general result for the whole army is that out of 186,469 men who "enlisted during eight years, 47,648, or one-fourth, had disappeared before the "end of the year succeeding that in which they enlisted; and 54,993 before the "end of the second year, with an average of little more than ten months' "service. These men had cost the country the enormous sum of £3,150,000, "without yielding any return, the whole sum having been entirely wasted. "After making due allowance for death and disease, and for dismissal for "misconduct, it is clear that 45,000 fewer recruits would have been required "during these eight years to keep the Army up to its strength: and if waste at "subsequent periods of service were included, it could be conclusively proved "that from 7,000 to 8,000 fewer recruits would be required annually, if only the "men were contented, and remained in the Service during the periods for which "they engage to serve. As the actual number of recruits enlisted below 19 "years of age during the last 9 years has been only 58,898, it is evident that if "this costly and useless waste could have been prevented, it would not have "been necessary to enlist any of these youths, and the army would still have "been complete to its establishment. This is a clear and definite answer to "those who say we cannot keep the Army full without enlisting boys."

Again he says—"The young soldiers by thousands yearly purchase their "discharges, or desert, while many break down under training, and return to "their homes without pensions, to drag out a miserable existence, and earn their "living as best they can, as invalids." And, in a foot note, "5581 men under "21 years of age have been discharged during the three years 1880-81-82; and "7,177 deserted during the same three years, having less than one year's "service."

In another place he says—"There can be no doubt from the General Annual "Returns presented to Parliament that, during the last ten years 150,000 men "have quitted the ranks of the army, and returned to civil life, who almost to a "man will give it a bad character, and whose testimony would act as a powerful "check to the blandishments of the recruiter. These are exclusive of men who "have gone to the reserve."

"The conclusion"—writes General Sir L. Simmons—"arrived at from the "foregoing considerations is that the outflow of men from the army must be "stopped without delay;" and his important paper ends with a warning that, if nothing be done, we shall quickly come within measurable distance of conscription.

The most grudging critic will surely allow that the training *may* have something to do with the discontent, and therefore may be worth examining into. For, what is more likely to influence men, to make them content or the reverse, than the details of their new calling? Are these details all they should be? Can they be improved? Is the invaliding of young soldiers in any way connected with the system of training to which they are subjected? Is the desertion of the men from the ranks brought about by it, even in a small degree? Is it dislike of the restraint of discipline that makes them desert, or is it something in the training that makes them physically uncomfortable? (They cannot earn their living at *anything* without some kind of rules and regulations and discipline.) At all events how you train a man will affect him *somehow*; and these questions are worth the trouble of considering. Young men are being invalided, and are deserting, in great numbers: Should we leave a stone unturned to find out why? No: Then let us turn this stone—their training.

For the information of those who do not know the extent to which the heart and lung diseases of young soldiers contribute to "the waste of the Army," I give what the late Dr. Parkes says, in his "Hygiene," on the subject.

"Out of 100 men discharged (*i.e.*, invalided) under two years' service, heart and lung disease together constituted in one year 47·85 and in the other 40.59." (The period referred to is from 1st July, 1860, to 30th June, 1862.) "In order "to form a standard of comparison which cannot be obtained from the civil "population (as deaths only are recorded in the Registrar-General's returns), I "compared this amount of heart and lung disease among young soldiers with "the same diseases among the invalids of all ages at Fort Pitt in two years. "The following numbers came out:"—

	Percentage of heart-diseases as causes of Invaliding.	Percentage of lung diseases as causes of Invaliding.
Invalids of all ages . . .	7·7	19·8
Invalids under two years' service	14.23	29.99

"Heart and lung diseases, therefore, form a much larger percentage among "the young soldiers; and this would have come out more clearly still had the "number of young soldiers been deducted from the number at all ages."

"How is this to be accounted for? The recruits are carefully examined; they "have no heart or lung disease," &c.

On the same subject Professor Maclean said, before a Meeting of the Royal United Service Institution:—"I had not been long in the position I have the "honour to fill in the public service before I became profoundly impressed with

"the vast losses sustained by the prevalence in the army of consumption, and "diseases of the circulatory system, that is, of the heart and great vessels. "Within the last three years, excluding those who die in regimental and depôt "hospitals, and those of the Household Troops (I exclude all invalided in "Ireland, of whom we at Netley see nothing), no less than 1,344 men have been "lost to the Service from consumption alone . . . . . . From the date "of my assuming charge of the medical division at Fort Pitt, in April, 1861, to "the end of last year, no less than 883 cases of diseases of the circulatory "system—in other words, a number nearly equal to the strength of a battalion— "have passed under my observation, and been lost to the Service, and this from "one class of disease; the great bulk of the cases being young men returned to "the civil population (that is, cast upon their parishes), and incapable of earning "their bread in any active employment. The pension allowed to such short-"service men is but a pittance, and that pittance is granted only for a limited "period. Let me remind you again, that in the figures I have given, the invalids "of the Royal Artillery, the Guards, and the troops serving in Ireland, are not "included: *they* were discharged without being seen by us at all."

"Surely, gentlemen, you will agree with me, after hearing a statement so "startling, that it behoves us to look narrowly into a question involving such an "amount of suffering, costly invaliding, and inefficiency, with a view to the "adoption of a remedial measure."

A grave and startling statement assuredly. And matters are no better to-day. Why? Because the same unphysiological, and therefore disease-producing "training" that obtained in those days, obtains now. No real remedial measure was adopted, because the evils of the training were not recognized. Evils! It was not supposed to contain any, but to be beneficial to the soldier in every way.

The first of these papers was published in the Army Medical Report for 1876. The second and third papers were submitted for publication in subsequent reports, but, for want of space, have not been published. I was fortunate to obtain a place for the first, however, which deals with the chief evil of the training: for, as a military paper truly said, on the issue of the Blue Book containing it—it is nothing short of a "revolution" that my reasoning points to. Such a programme—I did not undertake it lightly—will turn aside many a reader; but it will be allowed, I think, that nothing short of a revolution of some kind will check the waste of the army shown in the Official Returns. There are revolutions for the better.

The "advantages of the Army" are proclaimed by the Authorities in vain while the outflow of young men continues at its present, or anything like its present, rate.

Any and every possible cause of discontent, and of breakdown in health, should be looked to: and why not the training?

F. ARTHUR DAVY, M.D.,
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WOOLWICH,
JULY 18TH, 1883.

A CONTRIBUTION

TO THE

ETIOLOGY OF HEART-DISEASE IN THE ARMY.

(from Appendix to Army Medical Report for 1876.)

Mr. Myers has done good service in bringing into prominence, by means of his essay—the "Alexander" Prize Essay—the causes which, in his opinion, are at work in the production of heart diseases in the army: for, the disability under which the army has laboured, in this respect, and continues to labour, is very great indeed. He points out the much greater prevalence of heart affections of all kinds among soldiers than among the civil population, although soldiers are most carefully selected:—and after giving due prominence to such influences in the production of organic and functional cardiac diseases as Bright's disease, acute rheumatism, abuse of alcohol, syphilis, excessive smoking, &c., he rightly sums up that some other cause—to account for the excess—must be at work which is not at work among the civil population; and that that cause is to be found in the mechanical obstruction to the circulation which is exercised by the tightly-fitting clothing and accoutrements of the men. I am fully sensible of the importance of that conclusion; and it is much to be regretted that the soldier's dress, as now regulated, does not allow that complete freedom from constriction, which, when work is expected of him, he ought to enjoy. But taking, as I do, mechanical obstruction to the circulation, and excessive strain on the heart, to be the causes of the excess of heart diseases among soldiers, I think it is to be regretted that, in the admirable essay alluded to, the conditions by which mechanical obstruction and excessive strain may be brought about, are not more fully considered. One condition, or rather set of conditions, which exercises a powerful influence in the causation of heart disease in the army has not been discussed. It will be the object of this paper briefly to point them out. I allude to the manner in which the early training of the recruit is conducted. Mr. Myers' book has only the following paragraph on the subject. He remarks on the severity of the drill, but does not say in what the severity of it consists; and no solution is offered of the exhaustion induced by it:—"The training of recruits should extend over a longer period, and, like gymnastics, should not be severe at first. I have often seen recruits perfectly exhausted after their morning's drill, and I am led to believe that the course of instruction they undergo is, owing to its severity, particularly obnoxious to them, and it is one which, with the present uniform, is very apt to lay the foundation of much heart disease in the army." This exhausting drill is not further considered, but Mr. Myers' remarks constitute strong evidence against it. Training ought not to result in exhaustion; if it does it is bad training. I hope to make it plain, in the few short paragraphs which I can devote to the subject, that cardiac irritability, resulting from deranged innervation of the organ, irregularity of rhythm, inequality in strength in the cardiac contractions, as well as hypertrophy and dilatation, with their possible consequences to the efficiency of the valves and to the aorta, have their starting point in a great proportion of the cases invalided in the orders of the drill-sergeant; and that in obedience to him mechanical obstruction and strain are imposed on organs (especially on the heart) the integrity of which it should be the object of all training to preserve.

2.—It will be well to state, at the outset, that I base the claim of the argument on a consideration of the degree in which the physiological conditions, under which the heart and lungs perform their functions, are altered by the treatment which the recruit undergoes from the commencement of his career; and that the resulting mischief bears a definite proportion to the degree of this alteration in each individual recruit. Those are most injuriously affected who most accurately carry out the orders of the drill-sergeant. Now, I do not say that tight uniforms and ill-adjusted accoutrements do not aid in producing the unhappy result; their adverse influence has been amply demonstrated: but I do say that if the clothing exercised no injurious influence whatever, mechanical obstruction to the circulation and excessive strain on the heart can be brought about by other means. I will now consider the means to this end provided in the drilling of the recruit.

3.—The improvement of the physique of the recruit being the object in view, the following is one of the modes in which it is attempted to attain it. He is made to stand bolt upright, his head well back, and his chest, being dilated to the fullest inspiration, is *kept* as much as possible so dilated. I need not specify this attitude of "attention" further; an attitude useful for no kind or description of work. This artificial dilatation of the chest is the point on which I wish to fix special attention. I will show good reason for calling it artificial later on. Now, let it first be conceded that the regulation drill-sergeant regards this expanded condition of the chest as the chief object to be attained in the recruits standing before him. He calls it "setting-up drill." The drill would not deserve the name without it. Any recruit in the squad who does not keep his chest thrown prominently forward, and fully expanded, soon has his attention called to the fact. For anybody who will not concede this point, the following remarks will have no weight. I believe the surgeons of the army will concede it. We have, doubtless, all remarked the manner in which the soldier dilates his chest, and keeps it dilated, when he is about to be examined with the stethoscope: much to the annoyance of the surgeon. It is the lesson taught him when he joins: he is to the manner trained, not born; for in examining men for enlistment, I have never seen this dilating of the chest resorted to; as civilians they do not think about their chests. Need I add that the caricaturist of the soldier never omits to represent

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him with an abnormally large and prominent thorax. Perhaps even such a fact may point to an important truth. But without any remarks like these, I think it will be allowed that the condition described is forced on the recruit by the "setting-up drill." Though conceding the point, an objector may ask, "What harm results; the training is supposed to be beneficial; and large capacity of chest is an advantage?" To that matter I shall come presently; now merely remarking that increased capacity is of no advantage when obtained at the expense of mobility. But I may reply for the moment by asking how (if no harm results) is the "severity" of the drill which Mr. Myers proclaims, but does not explain, accounted for: or the exhaustion which he has seen, as I have, result from it? If merely prolonged drilling produce it, say under a hot summer sun, how is it that the drill-sergeant is not overcome or "exhausted"? He has the additional work of vociferating loudly all the time. If his being older has anything to do with it, so much the more reason for dealing gently with the recruit. No doubt he exemplifies in his own person the attitude he wishes the recruits to assume, but he does so only occasionally and momentarily. They are compelled by him to *maintain* this attitude, while he walks abouts with his hands behind his back. By an application of the law of survival, or rather non-invaliding, of the fittest, he remains to victimize as he has been, perhaps, victimized, to some extent himself.

4.—Let us now approach a body of dilated recruits as they are being drilled and examine one of them. The first thing to be noticed is that there is the great elevation of the ribs of full inspiration, even the scaleni muscles being in action. There is also great depression of the diaphragm; and the sternum is thrown forward. Our eyes are just being attracted to the abnormal character of the heart's impulse, when we mark with surprise that this distended condition of the lungs does not give place to a properly performed expiration; that little descent of the ribs occurs, or adequate elevation of the diaphragm: in other words, that the act of expiration is, to a great extent, in abeyance. This, because the recruit knows that he must, at all risks (discomfort notwithstanding, in most cases it does not amount to more at first), keep his chest expanded. Now, what consequences must certainly follow when this so-called training is persisted in day after day. I shall not speak of the heart just now; the consequences to it, of this training, are direct and immediate, as well as indirect. We know how inter-dependent the heart and lungs are; how influences affecting the heart soon affect the lungs, and *vice versâ*; but it must at once occur to the mind that, not only will the forces by which the important act of expiration is to a large extent accomplished in health (the elastic recoil of the lungs and of the chest walls) be, by repetition of this training, gradually diminished in power; but that, as the man stands before you, the blood in his lungs must be undergoing a deficient aëration. For as the diminution in size which takes place in the thorax when expiration is properly performed does not occur, it must follow that the air in the lungs charged with carbonic acid is not expelled to the usual extent, to be replaced by new air from without. Now in active exercise of any kind, it is of the last importance that expiration should be efficiently performed. Under these circumstances, a greatly increased quantity of carbonic acid having to be got rid of by the lungs, the respired, or charged, air needs to be expelled by strong expiratory movements, and fresh air inspired. In other words, the elastic power of recoil of the lungs and of the chest wall needs to be unimpaired. In very few soldiers have I found it so. The drill which the man before us is undergoing cannot be described as active exercise, and that is the only reason why the position is tolerable at all. Further reasons, showing that the chemical functions of the lungs are impeded by the maintenance of this attitude, will appear when the effect of it on the heart is being considered. Before proceeding to the latter I must add —what we should have noticed when inspecting the recruit at his drill—that in the gradual weakening of the forces by which expiration is normally performed, the overstretching to which the abdominal muscles are subjected by the training, is a very important factor. In normal expiration, the contraction of these muscles diminishes the cavity of the chest by pressing the viscera against the passive diaphragm, and so elevating it. In the artificial condition I describe, they are not only weakened by overstretching for this work, but their action is antagonized by the diaphragm being *kept* depressed.

5.—I think it will be admitted, from the foregoing account (which I might extend by a full review of the mechanism of normal respiration —if this were necessary), that the degree in which the physiological conditions under which the expiratory act is performed in health are altered, is great. This alteration cannot take place with impunity. Pathological states commence when physiological conditions are departed from :—but I doubt, as concerning the result to the lungs, that the word "pathological" will be admitted by all. For myself, I am convinced that vesicular emphysema, to some extent, occurs in nearly all the men—during the period of this training—from the continued and excessive distension of the air vesicles. Hypertrophy of the elastic parenchyma of the lungs might be expected to occur on the "ubi stimulus ibi fluxus" principle; but if it does it will not be compensatory and tending to the restitution of expiratory power; but will cause pressure upon, stretching of, and partial obliteration of, the functional blood-vessels,—the pulmonary capillaries. I conclude, then, that you may increase the measurement of the recruit's chest rapidly in this way; but that you do so at the expense of its mobility—at the expense of vital capacity: and that the recruit is thereby more or less unfitted for active exertion—one reason for which result I have already given.

6.—It has been shown that, sooner or later, the drill becomes distressing to the recruit. He is distressed, but still uncomplaining. It will be right now to inquire why it should so distress him. If good reason can be shown why it must distress him, and in some cases (as Mr. Myers has it) even "exhaust" him; it being at the same time admitted that exhausting, or even distressing, drill, cannot commend itself, on due consideration, to any well-regulated mind—then I consider that a claim will have been established to have this injurious drill

discontinued. We noticed when inspecting the recruit at his drill that the cardiac impulse was abnormal. We must now see more minutely what is taking place. We cannot hear his heart beat as we stand before him—I daresay he hears it himself and feels it too—but we can learn a great deal by watching the cardiac region narrowly. The organ, as I said, suffers early; and even before the man thinks of complaining a pathological condition has commenced.

7.—I propose, then, 1st, to describe the abnormal manner in which the heart acts in the dilated chest; 2nd, to give the causes of its abnormal behaviour; 3rd, to state why both one and the other (*i.e.*, the effect and its causes combined) produce exhaustion, or distress, or discomfort, or a mere feeling of irksomeness, as the case may be. Lastly, to consider the pathological states of the organ which may be induced.

8.—Now, I shall be excused undertaking for a few moments this task, which is the chiefest part of the inquiry in hand, in order that I may disclaim any intention of exaggerating the consequence of this "training." A cause loses much by being over-stated: more especially a cause like this, with tradition, prevalent mistaken notions of what "physique" means, military views, popular ideas, all against it. I would even take lower ground than Mr. Myers takes in the paragraph which I have quoted from his essay, lest it should be thought that I merely argued from the true and weighty statement which he makes, and leaves unsupported. It will be understood that I raise an issue quite distinct from the question of tight uniform and accoutrements, to which I shall, however, just allude presently. Now, pathological processes of great importance may proceed very quietly, and attract at first no attention on the part of the sufferer. Let us say the average recruit—speaking of those who withstand it best—would describe his dilating drill as merely irksome; or he might call it discomfort: I do not think he would often call it distress—at least in the earlier days. Some find themselves much distressed. But when the course of drill is over, he is just in the condition of heart (as we shall see) to be most injuriously affected by the next part of the training. For now come the pack, and the straps, and the rifle—too soon; for of the many hearts whose irritability or actual hypertrophy, established in the drill-field, had not been so great as to cause complaint to be made, what a large proportion will rebel at the additional load. If only an interval of rest had been given for that great power of recovery which the heart, in common with all other organs, possesses, to come into play, very many who are ultimately invalided, or who die, might be saved to the service. Officers in whom this "chest" drill induces this condition—about to be more fully described—are saved at this stage. There is no pack for them. They are free to recover—the private is not. Further, I would not be understood as saying that, in a short time, the men who suffer break down utterly, and become unfit for duty of any kind. This is the result to many of them. But I am sure that in the great majority of cases of heart complaints invalided (other than those brought about by rheumatic fever, Bright's disease, &c., of which the history is to hand), the early link in the pathological chain was forged on the drill-field. There has preceded the date of appearance at hospital a long period of uncomplained-of discomfort, often distress; consisting of breathlessness on slight exertion, headache, and "beating." Now exertion has become unbearable. A man who never knew he had a heart (an expression many a soldier has used to me), becomes aware of his possession after a few months' dilating drill. He blames his recently-donned pack and traps for his trouble; forgetting that as a civilian he could have carried them manfully across country for ten or fifteen miles. Now, has this man been enlisted by mistake? Or have we made him what he is?

9.—This has proved more of a digression than was intended. To return: We find then, firstly, that in the distended chest the cardiac impulse is lower down, and nearer to the middle line than it ought to be—the site of impulse often varying in successive beats: its area appears to be increased; it can be even *seen* to be abrupt and jerky, and in many instances there is marked epigastric pulsation. On placing the right hand firmly against the cardiac region, and the left on the back, we find the cardiac systole to be much more powerful than is natural; so much so sometimes that it shakes the body visibly. We are surprised at this, for the man has been only standing; and this excited action exceeds what would be expected even during active exercise. The condition of the walls and floor of the chest is maintained as before described; the respiration (shallow, and therefore increased in frequency), being performed by deficient elevation of the diaphragm (complete relaxation of it being prohibited) and very slight descent of the ribs; followed by the only further enlargement—by way of inspiration—that can take place: and this is very small, for lateral expansion has already been attained almost to the uttermost limit. The heart contracts about 110 times in the minute, the rhythm being irregular both in time and force, in many cases. The right ventricle is found to be acting unduly. The respirations average 40 in the minute. There is a curious mixture of anxiety and resolution visible in the recruit's countenance. The man before us may have no hypertrophy as yet; and no murmurs indicating valvular inefficiency can be heard.

10.—Now, secondly, the state of heart just described points to impediment—to obstruction to the circulation. We shall now see how the obstruction comes about. Tight clothing, &c., may well be a cause of obstruction from without. I shall show that the attitude which the recruit is compelled to assume and *maintain* (for here lies the mischief) is a cause, more powerful, of obstruction from within. Let it be remembered that "as the thorax is a closed cavity, in which a partial vacuum is produced by the act of inspiration, whilst its contents are compressed by the act of expiration, the former state will favour the movement of blood from the large veins on the exterior of the cavity towards the heart, whilst the latter condition will retard it." This quotation is from Carpenter's Physiology. This author then proceeds to detail an experiment (to quote again) "showing the suction-power of the inspiratory movement, and the expellent force of the expiratory act." I will, further, copy the sentence next following

in this well-known work. It is this:—"On the other hand the expiratory movement, while it directly tends to cause accumulation in the veins, will assist the heart in propelling the blood in the arteries." Can any one question the importance of these (or of any other) physiological laws? What, then, if the act of expiration be, to a great extent, in abeyance? A disturbance of the balance, which exists in health, between the pulmonary and the systemic circulations. This is the inevitable result—as we shall see. But will not the balance be restored as soon as the recruit is free from his tormentor, and allowed to breathe as nature would dictate? Yes, the balance will be gradually restored, and the heart will become quieter, only to be disturbed again at the next drill-hour. This is the manner in which we produce "physique"—the synonym for looking formidable on parade, and being useless for work: or else for doing the work in a condition of discomfort, distress, or exhaustion, as the case may be. I regret that I am betrayed into remarks such as these; but the British soldier is very brave. No man likes to "give in" less than he does. It is nothing short of pitiful to see him trained to break down, when the necessary "physique" might be secured by a little judicious padding, instead of at the expense of the heart and lungs. Considering that he is selected for being likely to prove efficient, I hold that—in time of peace at all events—the chances as regards heart disease are in his favour, rather than in favour of the civilian. I cannot now discuss this point. I am endeavouring to confine myself to the question of the artificial dilatation of the thorax embodied in the order "Swell your chest"; and just now to the manner in which the balance of the two circulations is disturbed by it—but I commend it to the serious consideration of the surgeons of the army, as being a tenable position, if only we would allow the soldier to breathe at all times physiologically as the civilian does—tight clothing and weight-carrying, in both cases, notwithstanding. The inspiration, then, a deep one—which the recruit takes at the word of command—produces physiologically an acceleration of the movement of blood from the large veins on the exterior of the chest towards the heart, which movement of blood towards the heart *had been retarded by the previously-occurring and duly-performed expiration.* Now, as expiration is not, after the word of command, again duly performed, and as the position of the thorax is one of deep inspiration and remains so—the diaphragm doing little to diminish the size of it, and the elastic recoil of the lungs and chest-walls being overcome by voluntary effort, does it not follow that, in a given time, a larger quantity of venous blood will have passed into the right side of the heart, than would have passed if the check, or retardation, which the expiratory movement properly performed exercises, had been imposed? I do not quite contend for a "vis a fronte"; if that were established for a moment, it would soon be disestablished. The right ventricle contracts vigorously, but the blood it drives forward for aëration cannot part with as much carbonic acid, or receive as much oxygen, as if respiratory movements were normally succeeding each other all the time. The degree in which the exhalation of carbonic acid suffers hindrance is in direct proportion to the impurity

(CO_2) of the air in the ultimate air-vesicles. This air is only changed (if it can be spoken of as being changed) by the law of diffusion of gases; but in the absence of efficient expiratory movements this law is at a considerable disadvantage, for the purpose required. If the recruit be now required to double—and when he is, he must maintain the same dilated state of chest, or be struck by the drill-sergeant below the epigastrium with a pace-stick—the dyspnœa is quite urgent. The right ventricle is much embarrassed. Now, this training causes dilatation in some, hypertrophy in others, both in most of those who suffer. Some do not appear to suffer. On inquiry you find these latter are nearer twenty-four than eighteen years of age. Even these may be the worse (without knowing it) for the drill. I would once more recall Mr. Myers' remarks to notice—the "severity" of the drill—the "exhaustion" he has seen. I think dyspnœa would be a good name to give to the exhaustion. Without saying more, it would call up the conditions which give rise to it. Dyspnœa in the recruit's drill-field means obstruction to the circulation, and obstruction to the circulation means excessive strain on the heart. This, again, means pathological changes in the shape of hypertrophy, with or without dilatation; and this, further, *may* mean (though, perhaps, it rarely does) inefficiency of the valves—for, if the orifices increase in size, the valves do not.

11.—Now, the systemic circulation is also injuriously affected, for the engorgement of the lungs, arising as described, must, however slight, result in a retardation of the current of blood in the pulmonary veins, which is taking place towards the left heart: and not only so, but the arterial blood reaches the left ventricle insufficiently oxygenated and also in deficient quantity. For not only is the lining membrane of the pulmonary veins extremely sensitive to the passage of impure blood, but a most important movement—which is, perhaps, one of the chiefest aids to the advance of the arterialized blood towards the left auricle—the expiratory movement, is being held in check. The force of the right ventricle may be said to be expended in sending the venous blood to the pulmonary capillaries, and as some obstruction is already there, the pressure exercised normally on the pulmonary veins in expiration is much needed to maintain the circulation in them. The right ventricle does all it can, and hypertrophies, that it may do more by and bye. The left ventricle receiving blood deficient in quantity and in degree of aëration, the wants of the system are not duly supplied, and the muscular and nervous structures of the heart itself must suffer. But the contraction of a deficiently-filled ventricle is mischievous to the ventricle, as is also that of an over-distended one. And distension of one side, and an insufficiently-filled state of the other, constitute, it must be admitted, a disturbance of the balance of the two circulations. Can we wonder, then, that when examining the recruit at his drill, we found his heart in the condition described? Is there not ample cause for it? The fact is, that expiration is forgotten (what does the drill-sergeant know about it?), and the erroneous opinion prevails that the man with the dilated chest is a fine, able, soldierly, fellow, although he might not be able to blow out a candle at a distance of two and a-half feet.

12.—We shall see, on a little further inquiry, that the "swelling" of the chest, ordered by the drill-sergeant, is totally indefensible; and nothing but evil can follow it. It should be recognized that the full powers of expansion of the lungs should never be exerted by an effort of the will—except under peculiar circumstances. For instance, the singer—in anticipation, not of the requirements of the system, but in order that he may have the requisite amount of air to expire for the execution of a passage which would suffer in effect if broken by a fresh inspiration—expands his chest to the full extent, to contract it again gradually but *immediately by a correspondingly deep expiration*. We take the same precaution in reading aloud, if we do not wish to draw our breath in the wrong place. It is for such requirements as these that the respiratory movements are placed so much, in the human subject, under the control of the will. But who will show that the breathing of the soldier on parade, marching, or doubling, should be conducted otherwise than automatically? The chest movements ought to vary in extent in accordance with the amount of blood sent into the lungs for aëration; which amount of blood, again, ought to be regulated by the natural forces which accomplish the movement of blood in the veins: but they ought not be impeded by attention being in any way directed to them. Much less should they be grievously hampered in the way I have described. The movements of inspiration and expiration (to put it more plainly) increase in depth, when the body passes from a state of rest into one of activity, for two reasons. Firstly, because the blood reaching the pulmonary capillaries is now flowing towards them more rapidly, owing to the pressure exercised, by the muscles, on the veins throughout the body. Secondly, because the demand for oxygen by the system is increased, owing to the increased chemical changes which take place as a consequence of muscular contraction. Now, the degree of chest-expansion which the recruit, as he stands to be drilled, is made to assume, is greater not only than would be automatically dictated by the conditions in which he is placed, but is even greater than that occurring as the physiological consequence of active exercise:—a degree of expansion, indeed, which *ought* to imply that vigorous muscular aid to the venous circulation was obtaining, and that, too, accompanied by movement of (as against a stationary state of) the body. Let us add these two conditions, making the man double—remembering that the chest *must still be kept* fully expanded—and what do we produce? At the very least we produce, as already shown, lung congestion, embarrassment to the right ventricle, and the consequent troubles which I will not again write of.

13.—We come, thirdly, to the manner in which the recruit's distress is brought about. I find I have written diffusely, and that, under the previous headings, I have, perhaps unavoidably, shown that dyspnœa is a certain consequence of the respiratory movements being impeded. I need not now repeat how: but I will say once more that expiration is as important as inspiration. For four hours a-day is that important act, to a great extent, in abeyance—and that for a period of about six months—for the recruit. Dyspnœa then, according to its degree, involves exhaustion, distress, discomfort, or a mere feeling of irksomeness, as the case may be. I have said that those who most accurately carry out the drill-sergeant's orders suffer most. Now, some men can attain, owing to their figure in general assisting the effect, a degree of thoracic prominence sufficient to please the military eye, without any very great hyper-distension of the lungs with air. Even for these the word "irksomeness" would, as a rule, but feebly express their sensations. There are other men who, being less shapely—being indeed, younger and unformed—can escape rebuke (and such rebuke! consisting of blows over the solar plexus, and very hard words) only by distending the chest with air to such an extent as speedily induces almost a doubling of the pulse-rate: of which result the deficient supply of blood to the left ventricle is the explanation. *These* men are distressed urgently, *in a few minutes*. An order to "stand easy" has not yet restored the disturbed balance of the pulmonary and systemic circulations, when this unphysiological process is commenced anew. This is obstruction to the circulation from within. It is worse than that (of tight uniform or accoutrements) from without. For, in the latter case the cause of the mischief is apparent to the sufferer—he can, and does in the fight, remove it. But he cannot know—and if he does he cannot remove—the disability inflicted on him in the drill-field: the existence of which it only required a little extra work and weight-carrying to make manifest. I say "a little" advisedly: for before enlistment has not the recruit either laboured all day in the field, or worked at his trade all day long with impunity? He must have done so, or he would not have been enlisted. The results of acute rheumatism to the valves we know:—the palpitation and irregularity of heart's action due to anæmia, general debility, or hysteria, we also know: but what is this? It is the result of the recruits being "perfectly exhausted by their morning's drill," and afternoon's drill too, day after day. Even if it could not be shown to be injurious, does not common sense disavow such a mode of training? Mr. Myers condemns it from this point of view, giving no reasons. It may well be that he thought they were unnecessary. He holds this mode of training to be "one, which, *with the present uniform*, is apt to lay the foundation of much heart disease in the army." Now, in support of Mr. Myers' opinion to a certain extent, and in continuation of, or deduction from, my argument, I will state that the training of the recruit as now carried on is—with, *or without*, the present uniform—*certain* to lay the foundation of much heart disease in the army. Dismissing this important subject in a few lines, Mr. Myers says: "The training of recruits should extend over a longer period." This would be quite unnecessary, as far as regards their well-being: the cause of the distress being pointed out, remove the great element in the training which induces it. Mr. Myers proceeds: "and, like gymnastics should not be severe at first." It should not be severe first or last. Train a man for severity, but, in the training, stop short of severity. I am now alluding to natural fatigue—the result of healthful work or training—which, of course, should not be excessive, except for urgent military reasons.

Fourthly, and lastly, what pathological changes may be induced by recruits' drill?

It is too much the habit to say that cardiac affections are merely functional, when we do not happen to hear cardiac murmurs. Functional disturbances of cardiac action may be and often are accompanied by murmurs; but, when do we see such a case in the soldier? The fact is that, examine as we may, we cannot find the organ, or decide upon the general condition—say of anæmia or plethora—which is to blame for this so-called "functional" disturbance, in the soldier. The case, at first sight, looks much less urgent, much less serious, than functional derangement, properly so called. Look, then, for organic disease. What other name can you give to hypertrophy? This is not to say that you cannot have a case of irritable, or "soldier's heart," without manifest hypertrophy; but neither is it to say that "soldier's heart" does not result from organic changes in the organ. Hypertrophy is very common in the army, and the manner in which it is certainly brought about by this drill (commencing in the right side) has been shown. Now (without repeating how), we saw that the blood reaching the left side of the heart was deficient, not only in degree of aëration, but in quantity, during the drill. The coronary arteries, then, convey more or less impure blood, in a deficient stream, to the muscular and nervous tissues of the heart. We also saw that the expiratory act is a powerful aid to ventricular contraction (Carpenter). The conditions of healthy ventricular contraction being so much altered, is it to be wondered at that rhythmical irregularity—due to partial arrest of the ventricular contraction—may be produced by a disturbance of the balance of power between the pneumo-gastric and the cardiac ganglia? Or, more commonly (Dr. Fothergill says), between the opposition offered to the blood to be driven and the power to drive it? Rhythmical irregularity is frequently associated with dilatation—though not necessarily so. We have a case of it now in hospital, of which the immediate exciting cause appears to have been very excessive muscular effort, in that much-to-be-condemned sport called "tug of war." (May I remark that when the tug of real war comes, such supreme muscular efforts are not wanted: staying power; weight-carrying power; presupposing an unimpaired condition of the heart and lungs—these are the qualities we look for.) There was no tight clothing in this case; but the right ventricle suddenly received more blood than it was able to dispose of, by the general and excessive muscular pressure on the venous system. This by the way. Valvular deficiency, though the valves be healthy, may result from distension of cardiac orifices. It would be beside the object of this paper to allude further to the possible consequences of the mischief commenced on the drill-field. It is right to say, however, that the great majority of the soldiers do not *complain* of recruit's drill. They endeavour to adapt themselves to, and to put up with, their new life and the inevitable distension; knowing that the better they do it, the sooner will they be delivered from the tormentor. Now, I will say again—though much repeating myself, I fear—that albeit the pack and other accoutrements may bring the mischief to light, they have only aggravated what they have been supposed in all cases to originate; *i.e.*, the excess of heart disease which obtains in military as compared with civil life.

I submit that I have shown that the mode of dealing with the recruit's chest is artificial, being in contravention of physiological laws; that it is injurious, and that to the most important organs of the body: that the causes of the visible embarrassment of the recruit's heart under training have not, in his interest, been sufficiently considered: that the embarrassment of the heart itself, which the training infallibly induces, has not been suspected of a significance that its continuance for many months for three or four hours daily might (as it does), induce organic disease;—in a word, that the recruit is the victim of the drill-sergeant's ignorance and superstition. I will add (though I deprecate making any remarks that may appear to be beside the question), that the evil is all the greater because it is done in the name of good. It is difficult to root out errors that have long prevailed, and the army is very conservative. But this expiration question ought to be attended to. The remedy is quite a simple one. It could be effectively detailed on one of these sheets of paper—and handed, if authority were given—to every sergeant or corporal who henceforward drills a squad of recruits. The men would work well because they would feel well; they would go through thrice the amount of actual exercise, and return to their barrack-rooms undistressed and un-"exhausted." For, were they not selected only the other day as in all respects eligible? This point does not receive the attention it deserves. We ought not to treat it as inevitable, or say, in an indifferent, off-hand, way, "better invalid him," when we find a young soldier of only a few years' service—who has yet had none of the vicissitudes, but the contrary, of military life—never abroad perhaps, better off in, than ever he was out of, the Service—suffering from hypertrophy or dilatation, or both, or these combined with and causing valvular insufficiency. There has been no rheumatism or Bright's disease. He may have had syphilis. (Comparatively, how few heart affections can be put down to this cause?) Why is his heart hypertrophied? Why is he breathless except when at rest? Because he has been a "man of war" (without seeing war), for a year or two? What would have been the chances against his finding himself in his present plight if he had remained a civilian? Shall we put it all down to the tight tunic and accoutrements, or shall we pay any attention to what has preceded the wearing of them; namely, the distress and "exhaustion" of recruit's drill (according to Mr. Myers' testimony); the departure from the physiological conditions of the circulation and of respiration, which I have shown that drill to entail. What shall we assign as the cause of hypertrophy already developed in recruits not yet "dismissed drill," and who have been "trained" in a loose serge frock? I have several cases of this kind now under observation. Some of them complained of "beating," others were discovered accidentally. Will it be admitted that a case is made out for the recruit? or are we to fall back on tobacco, alcohol, excesses of any kind, except excess in military chest-making—for causes of this most common disability? Courts-martial are frequent. Do we not all know

the soldier, who says he is "all right," whom, when we examine, before writing the required certificate, we find in the condition I describe? I am sure that if this mischief were not so universal, I would have modified the certificate many a time when I have not done so: and I might be slow to confess that I have often certified men to be fit for hard labour, trusting that, if it were awarded to them, they would, when in distress, appeal to the medical officer of the prison; if I were not obliged to reflect that discipline must seriously suffer if men, who state that they are "all right," were shielded (as it would *appear*) gratuitously. We are aware what a striking contrast would appear if the state of the heart of, say, 50 civilians were compared with that of 50 soldiers—taking those who have never been known to complain of cardiac trouble—and taking any civilian men haphazard of about the soldier's age. The soldier ought to have the advantage here. But he has not. The civilian can accomplish the distance, and carry the weight with less distress than the soldier. Why? Because the soldier has been trained. Mr. Myers compares the amount of heart disease in the Foot Guards with that in the Metropolitan Police, with the usual result. The soldier suffers most. Now, I confess I do not know whether the tunics of the police can compare in degree of tightness with those of the Foot Guards. They seem trim enough, and tight about the neck. Their accoutrements, too, may be less of a load; but may I not suggest that there is a great difference in the amount of "chest-drill" performed by these two bodies of men. Although I make these remarks, I do not want them to be regarded as more than supplementary. The position I have tried to maintain is that the recruit is compelled to outrage physiological laws, and that he must, and so must the Service for making him, pay the penalty. This is higher ground than has yet been taken in view of clearing up the question of the excess of heart disease in the army. I trust the surgeons of the army will take the matter up.

There are a few points, which I will not now touch upon, having an important bearing on the training of the recruit. These involve a consideration of the influence on the heart of "extension motions," done by the arms, while the chest is fully expanded and the body stationary; of gymnastics; and other matters of lesser importance:—If there should appear any inclination on the part of the military authorities to abandon the present evil way of drilling recruits, these points can be quickly stated at another time, together with plain directions as to the manner of avoiding the injury to the heart and lungs now being inflicted. I am now glad to dismiss the subject—hoping that I may have succeeded in directing to it the anxious consideration which, I am convinced, it deserves.

VUE DU LAC, GUERNSEY,
August 22, 1877.

A Paper concerning the Evils of our Present System of training Recruits for the Army: being a sequel to, and to be read in connection with, a Paper entitled—"A Contribution to the Etiology of Heart Disease in the Army," which appeared in the Army Medical Report for 1876, issued in January, 1878.

In concluding a former paper, wherein I pointed out the injury inflicted on the recruit by the drill-sergeant, in so far as the artificial dilatation of the chest and the interference with the act of expiration were concerned, I stated that there were some other points in the training of the recruit—some other practices of the drill-field—which ought to be inquired into; in order that a conclusion may be arrived at as to whether they should, or should not, be considered henceforward as helping to constitute a beneficial mode of training. I do not pretend to treat the matters now to be touched upon exhaustively: it will accomplish my object if this short paper succeed in drawing the attention of those most concerned to them: but I believe that enough will appear to show that, in the training of the recruit, he is called upon to obey orders which, though of course meant to benefit him for himself and for the State, are founded in error; and defeat the very ends they have in view. If the Authorities are only convinced that this is the case there can be no doubt that steps will be taken towards having the necessary changes made. I trust that the evils of distending the chest, as already pointed out, will be considered demonstrated; and that those now to be discussed—of minor importance comparatively, though nevertheless important—will be admitted to be evils, and abandoned accordingly. But if anybody can defend those practices of the drill-field which I now proceed to condemn, let him do so. Let him show wherein, say, temporary efficiency is increased by them: or beauty, or grace, in the human form divine. If, on the one hand, they can be shown to be opposed to natural laws, and therefore injurious: and if, on the other hand, no one can defend them as expedient, though admittedly injurious; then no reason exists why they should be any longer countenanced by the Authorities.

The best way of commencing will be to take the objectionable portions (as I consider them) of the orders respecting the "position of the soldier"—*attitude* of the soldier is meant—which are contained in Sec. 1. Part 1 of the drill-book, and to criticise them by the light of anatomy and physiology. This I shall do briefly. Other objectionable portions I shall consider later on.

After giving some preliminary directions regarding the "position of the soldier" which do not call for comment, this section orders that "*the hips*" are to be "*rather drawn back, and the breast advanced but without constraint*—what safe guidance for a drill-sergeant—*the body

straight and inclining forward, so that the weight of it may bear principally on the fore part of the feet.*" The knees are to be "straight" and the heels together. Now, in these instructions the part to which I wish to call attention is that which directs that the weight of the body may principally bear on the fore part of the feet. I cannot help remarking at the outset that even before looking into the matter, there seems something very unnatural in telling a man the manner in which he is to dispose the weight of his body. If a member of the monkey tribe could understand your language, and you proceeded to advise him as to the best way of disposing the weight of his body, he might well stare at you: and would probably intimate, if he could, that he was not aware he had need to be told it. Every man who is free from all brain disease may be said to know—though knowledge is not the word for it—the best way of disposing the weight of his body: and every such man may also be said to be quite unaware that he knows it. We must presume, of course, that the order I have quoted, which it is attempted rigidly to enforce, was drawn up with some definite object in view—perhaps several objects. What can these be? It is quite a simple matter to stand straight: but to keep your "body straight and" yet "inclining forwards"—the feet being together and immoveable, with no flexion of the knee-joints—is not by any means an easy thing to do: you have to bring your muscles strongly into play to prevent yourself from toppling forward. This must be one of the objects in view, let us suppose—the development of the recruit's muscles. Or, a man in this attitude may be thought to convey the impression that he is a very formidable fellow—much more formidable than if he merely stood straight. Or again, this order has for one of its objects—indeed I am at a loss to imagine what can be further advanced as a plausible justification of it. Section 5. of the drill-book, in introducing the extension motions, which form a part of the recruit's training, gives a *resumé* in a few lines of what it is desired to attain by their means. But section 1, on the attitude, or "position, of the soldier," is silent as to the advantages of the same. Has it any advantages? Is it right that recruits should be instructed to make the fore part of their feet bear the principal part of the weight of their bodies? I shall now show that this order is altogether wrong: and the idea that the muscles of the lower limbs can be properly developed by carrying it out, will be shown to be erroneous—not that I imagine for a moment that the muscular development of the recruit was thought of when these instructions of sections 1. were being drawn up. Later on something will be said on the "position of the soldier" in regard to the opinion commonly held of it that it is a manly, or a beautiful attitude or "position," for which it would be advisable to put aside the minor question of health—*i.e.*, efficiency.

Writing of the "thorax as a whole" Quain's Anatomy has the following remarks. They are observations in which (it may be said) all anatomists *must* agree. "Its longitudinal axis is directed upwards and slightly backwards. Its transverse diameter at its widest part greatly exceeds that from before backwards. The latter is shortened in the middle line by the projection of the vertebral column; but on each side of the column a considerable extension of the cavity is produced by the backward direction of the posterior parts of the ribs, *and thus the weight of the body is thrown further back and more equally distributed round the vertebral column.*" In another place the curves of the spine are spoken of as "connected with the maintenance of the erect posture," and as assisting in preserving the equilibrium of the body. Milne-Edwards, in his Zoology, speaks of the *erectores spinæ* muscles as being "intended merely to raise the body upright *and to counterbalance the weight of the viscera situated in front,*" (the italics are mine). Now, what is all this but to show that nature endeavours to make the maintenance of the erect posture depend on mechanical means, and not on the employment of vital means. In other words the aim, as evidenced by the form of the skeleton, has been to secure the maintenance of the erect posture with the least possible expenditure of muscular force. If, let us say, the thorax were all in front of the vertebral column, then this would necessitate the lumbar spine taking a somewhat different direction:—the pelvis would have to be more forward in order properly to transmit the weight: or else it would necessitate the occurrence of strong and continuous muscular action on long feet to prevent the body from falling forward. Now, if a man be made to incline the upper part of the trunk forward, without being allowed to bend either his back or his knees, or to advance his pelvis or to move a foot, he is made to overcome the tendency to fall forward—in fact the law of gravitation —by means of his muscular power. And, so long as he remains faithfully in this attitude, whatever muscular effort is required has to be kept up continuously—both feet on the ground, and one limb not relieving the other. The degree of muscular effort required to keep the body from falling forward in these circumstances will vary, of course, with the weight of the body, and with the degree in which it is inclined from the perpendicular. Young recruits commencing to practise this attitude may be seen constantly toppling forward out of the line, or putting one foot out to preserve their gravity. This stage does not last long. They are not allowed to keep on repeating these *faux pas*. How does the recruit deal with the difficulty, then, of having to assume an unnatural attitude? This point will now occupy us. Before discussing it I shall give an extract from Milne-Edwards' Zoology, showing how false to nature the position of the soldier is. "Para. 284. *Station or Standing.* With the exception of serpents most animals rest on the soil by means of limbs or extremities. They stand by means of the action of the extensor muscles: and thus standing for a long time erect becomes more fatiguing than walking, for in this the flexors and extensors are used alternately." Para. 285. "But the body must also be *in equilibrio*, or balanced on its base of sustentation, and the point around which all its movements are performed is called the *centre of gravity*. Now, to support the centre of gravity it is necessary that the base of sustentation be situated vertically below the centre of gravity. The wider, then, the base of sustentation the more secure the position: thus, we stand safer on two feet than one: on the sole of the foot than on the toes or heel, &c.: for in proportion to the extent of the base of sustentation, so may the centre of gravity be displaced

without risk of its falling beyond that base. The law holds good for all heavy bodies, &c." We now return to the question, how does the recruit deal with the difficulty of having to assume an unnatural attitude? Now, by careful observation I have noticed how he effects a compromise between the drill-sergeant and the drill-book on the one hand, and his natural inclination as to the disposition of the weight of his body on the other; so as to appear to obey and yet not obey this order implicitly. He soon finds that to obey it implicitly means great, because continuous, strain on the muscles of the calf of the leg during, sometimes, many minutes: not on those of one leg at a time—as in running or walking—but on both together; no period of repose being given for the nutrition of the muscles. He would like much to ease them by letting the calcaneal end of the longitudinal arches of the foot support its portion, *i.e.*, the greater portion, of the weight: but to do this would be to cease to incline the body as directed, and to make the heel bear the principal part of the weight; which common sense, backed by Anatomy, says it ought to bear; but which the drill-sergeant, backed by the drill-book, says it ought not. To relieve his muscles being the urgent matter, the recruit allows the pelvis to go a little forward: which movement—although the weight is still on "the fore part of the feet" —has the effect of making a very slight arch of the whole body, and so lessens the expenditure of muscular power required to maintain the attitude: for the quadriceps extensor femoris, previously in strong action, is now relieved; and the patella drops down from its position in contact with the femur. That the men resort to this expedient of advancing the pelvis is well known to drill-sergeants, who combat it by blows on the abdomen with the pace-stick, and telling words, such as they deem descriptive of the appearance produced by it; and calculated to awaken in any nice-minded recruit the determination never to resort to it again: —not to speak of the more powerful persuasion of the pace-stick. The pelvis must be kept back, while the chest is kept forward. What can the recruit do now? The uneasiness produced by the prolonged strain on the muscles—of the calf especially—as well as by the overstretching of the posterior ligaments of the knee-joints and about the insertion of the hamstring tendons, makes him decide to bend the knees somewhat; or rather to allow these joints to pass into a position of less complete extension. I have noticed this frequently. But, as this gives little relief the pelvis again comes forward, in spite of the man: and while it is only a little, this attitude constantly passes without comment from the drill-sergeant. When in front of the line he does not easily notice it. But when he goes to the end of the line to see to the "dressing," he notices the general arching, and being now much irritated, he walks quickly along the line sharply striking every prominent abdomen, until these wretched recruits are driven to adopt the only remaining expedient—which the drill sergeant is only too willing they should adopt, for is it not part of the "training"?—of further dilating the thorax (in the manner and with the results I described in a former paper) so as to appear as if the body were inclining forward, and to appear as if the weight of it were being all the time borne by the fore part of the feet. Here then, is an additional incentive to thoracic dilatation in the drill-field. Of what avail to say the chest is to be advanced but "without constraint." What does a drill-sergeant understand by that expression? It is a case of one evil producing another greater evil, because we will persist in believing that the moment a man puts on a red coat the disposition of the weight of his body must be removed from automatic control, and he himself in other respects from the provisions of natural laws—laws, too, affecting the functions of the most important organs of the body.

Irrespective, however, of what it thus leads to, this order for the disposition of the weight of the body is wrong, firstly, from an anatomical point of view—involving, as it does, the adoption of an erect standing posture not contemplated by nature. As we have seen, it renders nugatory to a certain extent the provisions of nature for an easy erect posture. It is wrong, secondly, from a physiological point of view, because the immediate consequence of its being obeyed is the occurrence of muscular contraction of a kind which interferes with the proper nutrition of the muscles: that is, in so far as the order is obeyed, continuous contraction. Now, continuous contraction of a muscle is not meant to take place. It is unphysiological; for it quickly induces painful fatigue of the muscle so contracting. Indeed, continuous muscular contraction is properly viewed as disease, if it take place independently of the will. I speak of the voluntary muscles in general. It cannot be said, in this sense, to take place independently of the will in the soldier who is put into this attitude; but continuous muscular contraction occurs necessarily in consequence of the assumption and maintenance of it. If it does not occur the body falls forward. In healthy muscular action, relaxation quickly follows contraction. Apart from our consciousness that a set of muscles cannot be kept long contracting without harm, physiology points out that every fibre of a contracting muscle is not constantly in action:—so important is it that the chemical changes between the blood and tissues should proceed uninterruptedly. It seems needless to me to press this point. Even the heart has its period of repose for its nutrition. In the near approach of death by asthenia, when the pulse becomes very frequent or uncountable, the factor in the case now chiefly determining death is this:—that the pause between the cardiac contractions is of so short duration that the nutrition of the organ well-nigh ceases, and so it quickly becomes unable to maintain the circulation. I shall quote in this connexion a short paragraph from Milne-Edward's Zoology. (Para. 258) namely; "*Duration and force of muscular contraction.* The contraction of the muscular fibres is a phenomenon essentially intermittent: they relax and contract alternately. Even the heart does this; but the voluntary muscles require a much longer period of repose." I would add, too, that muscular action to any great degree, ought to result in movement; and when the muscles of the lower limbs are thus acting, in progression: and this should be especially true for the training of the soldier: but here we have muscular action, strong and continuous, to maintain a motionless erect posture; which nature arranged to be maintained with the least possible expenditure of muscular force. Finally, this order for the

disposition of the weight of the body is wrong, from a mechanical as well as from a physiological point of view, because, in so far as it is obeyed, it does away with the advantages of the arches of the foot, and in time actually flattens them. Writing lately (9th March, 1878) on the subject of high-heel boots, the Lancet says:—"It does not need a knowledge of anatomy to convince the shallowest thinkers of the sex which worships the idol of Fashion, that the foot is forced into a wholly unnatural position, and distorted, by the heel being raised, *and the body made to rest on the ball of the toes.*" Italics mine. "It should be unnecessary to explain that this disturbance of the foundation throws the whole superstructure out of gear, and deranges every mechanical function." It may be said that this is not a question of high-heel boots. No: but it is a question—which the Lancet treats in the above general way under that heading—of the use or abuse of the arches of the foot; the ligaments and fasciæ supporting which are overstretched by the unnatural, because continuous, strain imposed by the "position of the soldier:" and, moreover, so overstretched in many cases as to produce flattening of the feet in men who were not flat-footed when they enlisted. Men are rejected who present flattening of the arches of the feet: the Medical Regulations laying it down that "the feet are to be arched, not flat." For, not only is this flatness necessarily accompanied by deficient spring and facility of movement, but it is one of the signs of a general inferiority of, perhaps, life-long standing; and not brought about during recent years by any special cause acting on the feet of the individual offering himself for enlistment. Yet how frequently do we find soldiers, and young soldiers, whose plantar arches are so little marked, or almost absent, that we would have rejected them if they had presented the condition a few years before. It may be objected, again, that the soldier is not directed by the drill-book to raise his heels off the ground in assuming the "position of the soldier:" and this is true as far as words go—though in some regiments the drill-sergeant convinces himself that the heels are actually raised off the ground, by trying whether he can pass a piece of card-board or paper under the heels or not—but let any one who raises this objection try for himself, whether, in the carrying out of the order to make the fore part of the feet bear the principal portion of the weight of the body, the heels are not practically off the ground, if not actually so. I mean to convey that if this trial be made it will be found that *no* weight is borne by the heel-end of the longitudinal arches in this attitude, which is called the "position of the soldier." The weight is not "principally" but altogether thrown on the fore part of the feet, so long as the soldier keeps trying to do what he is ordered—and it is surprising to what an extent the men carry out these injurious follies:—but even if it were possible to avoid exceeding the order when it is attempted to obey it; even on that supposition the order is wrong. *Both* the piers of an arch are meant to bear the super-imposed weight; and in the human subject the calcaneal end of the longitudinal arches is meant to bear by far the greater portion of it.

It may occur to some to say that in walking up even a long flight of steps many persons never put the heel down: or that it is possible to walk and to run on the toes for a considerable time without experiencing any fatigue or sensation of overstretching: and that therefore it may be that I have overdrawn this matter. Now, it is exactly for the alternate strain (or action) and rest which these conditions involve that the muscles, ligaments, and fasciæ, are fitted. Not only is there time, in such exercises, for the repose and nutrition of the muscles of one limb while those of the other are contracting, but there is the period, for each limb in turn, during which the ligaments of the joints are no longer on the stretch. It is a very different thing indeed to make a man *maintain* the motionless "position of the soldier" for, say, two or three minutes. The cases are not similar; and I only introduced what might appear a difficulty to some, in order to put it aside. It will always be true that muscles are not meant for continuous contraction, and that ligaments are not meant for continuous strain. If we stand chatting carelessly, we change the limb bearing the weight of the body every half minute or so, being scarcely conscious that we do so. Continuous strain and undue fatigue are thus avoided. The man who performed the great dancing feat, recently recorded, of waltzing unceasingly for some 12 or 14 hours—I am not sure that it was not many more—would have failed to stand faithfully in the attitude or "position" in which the soldier is placed for a twentieth part of the time. The fact is, no *real* work, labour, or exercise of any kind, requires the maintenance of the attitude ordered in the drill-book. Not being contemplated by nature the body is not fitted for such a standing attitude, and therefore the body is injured by adopting it. These remarks apply to that portion of the order for the "position of the soldier" (Sec. 1) which I undertook, in commencing, to criticize.

We now come to the Extension Motions—contained in Section 5. of the drill-book. It will not be necessary to say much about them. The very words in which they are introduced—"in order to open his chest, and give freedom to his muscles, the soldier will be practised in the following extension motions"—condemn them utterly. It was shown in my former paper to what the opening of the recruit's chest amounts. It is so quietly taken for granted that to "open his chest" is a highly beneficial operation that it is not surprising that question as to its advisability has not arisen. The drill-sergeant, taking the drill-book as his infallible guide, argues, no doubt (judging by the results), that if it be a good thing to "open his chest," the more it is opened the better. And, for the end in view, he could not be provided with more potent means. I had thought of copying out all these extension motions, but it would take too long. Let it suffice to say that the end they have in view—the opening of the chest—is a bad one, as we have seen: and that they are admirably calculated for the attainment of it. And the means devised for giving "freedom to his muscles" result, not in their freedom or due exercise, but in overstretching of, and continuous strain upon, them and their tendons of insertion; as well as upon the ligaments of the joints. While, however, I commend to the reader for perusal at length the extension motions of the drill-book,

I may draw attention to one or two points more particularly. The "first practice" has the following:—"On the word *Two*, throw the hands up, extending the arms smartly upwards, palms of the hands inwards: then force (I would call attention to the wording) them obliquely back, and gradually let them fall to the position of attention (!) *elevating the neck and chest as much as possible*." It is fair to say the italics are mine. After this comes the apoplectic amusement in which the recruit bends forward to accomplish the trying task of touching the ground with his finger-tips, knees unbended; to resume, at the discretion of the drill-sergeant, his attitude of "attention," with his mouth open, gasping for breath, with prominent eye-balls, and a purple face. I admit—if when a soldier picks up anything from the ground—say a rifle—it is absolutely necessary that he should do so without bending his knees—I admit, I say, that in that case this practice might be defended from a military point of view. But it is not the rule to prevent the men from bending the knees in such a case. When, therefore, will a man be required to put himself into such a ridiculous posture (to say no worse of it) as this is, for any useful purpose? Never: and if never, why ever put him into it. Again, there is the following in the "third practice:"—"On the word *Three*, swing the arms round as quickly as possible from front to rear." In this the arms are extended and the fists clenched. Now, when is the soldier likely to be called on to perform a feat of this kind for any useful end? Even the railway porters, who use their arms for signals, and throw them on occasion very wildly about, are exempt from any wearying preparations of this kind. What I wish to press is this: that instead of wasting time at exercises which are not only hurtful but useless, recruits should be made to practice such work as they will have to do in the field. It may be said—"We cannot make a man march correctly without these preliminary exercises." Well, with them you make him march with his heart in his mouth, and you cannot know how he may be made to march without them until you try. It may be said again, "without these extension motions, and this setting-up drill we cannot get men to take the regulation length of step." I reply by asking whether anyone seriously thinks that the attainment of this, which is altogether a matter of habit, of practice, is facilitated by the over-stretching of muscles and ligaments. I do not admit that all the men we pass into the Service require this "pulling into shape,"—supposing for a moment that it can be attempted to be done in this way without injury. Many of the men enlisted are, no doubt, of clownish appearance, and walk with slouching gait—one shoulder lower than the other perhaps—or who display some trick of attitude the reverse of smart. And I, of course, agree that all this should be corrected in the men who are admitted into the Army exhibiting such departures from soldierly symmetry. But it can be done without injuring these men. It has often surprised me that the attitude I have seen British man-of-war's men assume, when about to be inspected by the captain of the ship, would not be tolerated in a soldier, nor even in a marine! It is not sufficiently "attentive." A post-captain does not object to it, but a colonel would not hear of it. The men stand straight and look to their front—as the military books have it—looking like men, and unlike puppets, thoroughly unconstrained and comfortable: their respiration unimpeded, and no unusual muscular action going on to support an unnatural attitude. This will not be allowed to be sufficient for the soldier; but can any one advance any *real reason* why it should not be held sufficient? Surely a man can stand erect, look to his front, keep his shoulders square, and look "every inch a man," without infringing natural laws. It is with diffidence I write such a very unquestionable fact. Indeed, I am surprised that this "training" should need to be written about at all for condemnation. If men are not told to "swell their chests;" and if they are not told to make the fore part of the feet bear the principal part of the weight of the body: and if, moreover, they are not told to do extension motions, which have the laudable object in view of "opening" their chests; we may rest assured that they will do none of these injurious things.

I had almost omitted something of importance with regard to the extension motions: namely, that they are practised when the body is, and has long been, stationary; and at a time when the balance between the pulmonary and systemic circulations is disturbed, as already described in my former paper: at a time, that is, when the considerable muscular action they involve adds much to that disturbance. The muscles, too, of the lower limbs are kept in a state of well-nigh continuous contraction in order to prevent the body from falling forward: there is no even occasional flexion of the knee-joints, or of the thighs upon the trunk, such as would occur if ground were being gained, and such as would indirectly aid the ventricles: but while the recruit swings his arms round "as quickly as possible," until the drill-sergeant chooses to stop him, and until his hands are blue from venous congestion—for the centrifugal force thus produced affects the return of the venous blood—there has been no more *movemen* of the body than the slight swaying motion backwards and forwards which the weight of the swinging arms occasions. I press it that muscular effort to this degree ought to be accompanied by movement, by progression, of the body: which would ensure the needed period of repose for the nutrition of the great extensors of the limbs when the flexors are in action; and for the flexors when the extensors are in action. Instead of this, as regards the lower limbs, you have the muscles overtaxed by continuous contraction to maintain the erect posture against gravitation, in so far as the recruit obeys the order to incline the body forward—which continuous contraction causes a continuous, instead of an intermittent, compression of the deep veins, and by interfering with the nutrition of the muscles (to the same degree in which it does so), embarrasses the capillary circulation. The extension motions, then, are admitted by the drill-book to have in view an object which I demonstrated in a former paper to be bad: and, otherwise, they are directly injurious to the circulation in the circumstances in which they are practised: inasmuch as they require for their execution considerable muscular exertion at a time when, in consequence of the inefficient manner in which the respiratory movements are being performed, the slightest exertion only adds to the

embarrassment of the heart. They are further injurious to the circulation because they impose the adoption and maintenance of positions, and of movements, which are calculated to hinder, in a manner in which legitimate work or exercise never does, the return of venous blood to the right side of the heart. This has been already spoken of in the centrifugal force brought into play by the swinging arms; and in the stooping attitude (with extended knees), which brings about rapidly a great amount of venous congestion of the head and neck, accompanied by a sensation of fulness or bursting. If it be said that they can produce these results to no very injurious degree, is this any justification for permitting their continuance? In what manner, in these enlightened days, do we wish to have the evils of venous obstruction demonstrated, before we are willing to give up the things that produce it? Is not a gasping recruit with a purple face sufficient: or must we wait for vertigo or apoplexy before we apply that dreaded remedy—common sense? As a matter of fact, vertigo is very frequently complained of by men undergoing "training." They speak of it as "reeling round," as "dizziness," and as "losing the sight of their eyes." We may safely presume that many suffer in this way who do *not* complain. Disturbance of cerebral circulation induces this giddiness; and if a young soldier comes to you from the drill-field, telling you that he first felt it there, to what conclusion—in view of these extension motions and attitudes—are you driven? I only want the military authorities to allow that the soldier would be better off without these "exercises." The abandonment of them would necessarily follow.

I would now call attention to a matter which has already occupied us in order to point out that, even on the supposition that there was nothing injurious in the "position of the soldier," the soldier is kept standing still much too long. As we have seen already, standing still for a long time erect becomes more fatiguing than walking. Now, this is true even of standing in an attitude of ease; of an attitude assumed unconsciously, if so be that this attitude is not frequently altered by changing the limb bearing the weight of the body—which one does without mental effort, automatically, every minute or so. If then this be true in this case, how much more fatiguing must it be to remain long in the attitude of the soldier? I have watched the proceedings of drill-sergeants very often in order to ascertain their discretion in this matter. While a troublesome recruit is being distorted the remainder of the squad stand fast as already placed by them: and, as regards the "setting up" of the men, the length of time they are kept standing appears to depend on the number of men being "set up." There is no such thing—and I have looked for it—as allowing the recruits whose attitude passed muster, to abandon it and *move about*, while their less prominent next-door-neighbours are being attended to. Not that I recommend any such miserable compromise. As will be seen, I recommend for the training of the soldier the practice of any and every such hard work and exercise as he is ever likely or liable to be called on to perform in the field; to the complete exclusion of the evils I condemn. Such a programme will fit him, and not unfit him, for his calling: and will surely, if adopted, bring the heart disease of the army down to below that obtaining in civil life. For—let the advantages the soldier enjoys in time of peace be remembered. (I speak of time of peace). What is there that is not done for him? And this, too, after he has been carefully selected as sound in all respects.

To gymnastic exercises—for the improvement of the recruit's powers; the powers of youth and health which he brings with him into the Service—I turn with pleasure. It is a relief to reflect that here at least, in the gymnasium, the soldier has no orders given him (excluding the extension motions) obedience to which involves a breach of natural laws. It may be that some of the exercises which are here practised are the means of wasting time which might be better spent—at aiming drill, say, or judging distance, or bayonet exercise, or *anything* a man will be called on to do in the field. For the day has gone by when supreme muscular efforts were the means by which fields were won: and I question the advisability of making soldiers gymnasts *to any great extent*, simply on account of the waste of time involved, and the misdirection of energy:—nothing could be more reasonable, however, than to set about making them pedestrians—but, at least, a gymnastic course can have nothing said against it, if it be conducted carefully, as it is supposed to be in the army. The men generally speaking like it, and most of them view it in the light of a recreation. Their hearts and lungs are not artificially interfered with: they may be said to be *working at ease* in the gymnasium; and if the work itself be sometimes hard, there is nothing to prevent the heart and lungs of healthy men from rising to the occasion, so to speak. And they do rise to the occasion and are thus strengthened and improved. It is unnecessary for me to speak of gymnastic exercises further. I only introduced them, indeed, in order to say one thing; which ought to be now self-evident: namely that recruits who are undergoing the system of chest-drill which I denounced in my former paper—those of them, at least, who do not succeed in evading the drill-sergeant's orders; and though many do evade them, none are supposed to—must necessarily have their troubles aggravated by gymnastics or *any* considerable exertion. They require rest; so that nothing may postpone the restoration of the balance between the pulmonary and systemic circulations, disturbed by the drill: for, as we well know, if irritability be once established, with or without manifest hypertrophy, it may result in months of rest in hospital being required; and then probably in the invaliding of the subject of it. The surgeons of the army know how these cases keep on reappearing at hospital. Though apparently all right when discharged, no sooner is any work expected of these men than back they come to hospital. The reasons why exertion in this condition aggravates the existing mischief, and so brings it to light, I gave in my former paper, and also when writing of the extension motions. I do not wish to repeat them. Gymnastics must be said to be good, and chest-drill is shown to be bad: but, *if they are practised together, then* gymnastics are bad. This is, of course, only another way of saying that the recruit has been rendered unfit for gymnastics by the unnatural treatment he

undergoes in the drill-field. I mention this because I find the following in the Queen's Regulations, sec. 10, para. 8. "The Gymnastic training of recruits is to commence simultaneously with the squad-drill:" to which there could be no objection if the drill were shorn of its injurious portions. While these are retained—and it seems absurd to suppose they will be retained—the gymnasium is to be avoided. But it is needless to say that I do not suggest that the gymnasium should be avoided, but that the evils of the drill should be discontinued altogether. I trust that due thought will be given to this matter without delay; and that the benefits to which our knowledge as medical men enables us to point, will be extended to the soldiers on whose behalf we write. To what end, indeed, is the education of medical men for the army, if their advice and recommendations be not attended to. I appeal for action in this matter, not on the strength of an opinion merely stated as such; but on the strength of the fact that a system of drill is now in operation which is proved to be bad, and which is chiefly responsible for the excess of heart-disease in the army. If any one objects to the latter portion of the sentence just written for the army at large, it must at least be admitted to be true for the young soldiers who are invalided, and for those now in hospitals, for irritability, hypertrophy, and palpitation, within a short time after joining. Or else the objector must take the onus of accounting on clearer ground for the prevalence of these affections in men who have been drilled in a loose serge frock, and who have never worn a pack, or a strap, or a tight tunic—the things which bring the condition, hitherto bearable, to notice. Surely we are entitled to expect that, if it be decided not to abandon the mischievous portions of the drill, *some* justification, from a military point of view, shall be put forward for retaining them. If they can be defended as being military necessities—for to these we must bow—let them be so defended. Until that is done they constitute a blot in the training of our soldiers. The Medical Department at least has done all it can to have that blot wiped away: and it will not be our fault if it be said, as doubtless it will be said, if nothing be done, that anatomy and physiology are branches of learning which exist in vain for the soldier. For him the word is "discipline:" he must do what he is told, even though it injure his heart and lungs; and, like the Irish recruit who once told me, as if dreading to complain of it, that the discipline in his regiment was "*very severe*"—meaning (as I had some difficulty in discovering from him) that the "setting-up" drill and all that pertains to it was what he understood by the word discipline—the soldiers generally regard this drill, this "discipline," as something not to be spoken against. As pointed out elsewhere, they firmly believe it to be a training which will eventually prove beneficial to them in every way—especially as to there new calling!

Considering the importance of the subject I shall be excused if I here allude to some recent utterances of Mr. Hardy's in the House of Commons,* on the subject of recruits. It seems there had been complaints about the *youth* of the men joining at Aldershot: and, in order

* Delivered in March, 1878.

to arrive at a just estimate of the real state of matters, Mr. Hardy "had a table prepared" (I quote from Mr. Hardy's speech) "first of all as regards men under one year's service, but dismissed drill. These were taken from 21 different corps, and I (Mr. Hardy) find there were 1452 men whose average weight was 10st. 7lb., average age 20 years and 1 month, and average chest-measurement 35 inches. Though some of these are boys—not many—you have not in these regiments a bad class of recruits. [*Quoted from newspaper report*] (hear, hear). And taking the recruits still at drill, you have the same averages I have just given. The Commander-in-chief went down this morning to inspect the men, and he has written to me to express the great satisfaction which he felt at what he saw. *He was very much struck with the men who have passed the drill*, and he is quite sure we have a good class of recruits. (hear, hear.) I hope the committee will consider that this is not an unsatisfactory state of things; though I still feel it is a great misfortune that the men are so young; and I think it is also a misfortune that men should come into the army saying that they are older than they really are. *However, they are of that class which will make good soldiers, because they become physically stronger after they have entered.*" I have taken the liberty of underlining two passages in this extract from Mr. Hardy's speech, which appeared to be received with satisfaction. I read this extract with dissatisfaction and regret, knowing the kind of training about to be adopted to make them "physically stronger." I shall be credited with only a good intention in having ventured to draw attention to it: for I do so only in order more forcibly to point out how deeply rooted in the public mind is the idea that a bolt-upright, dilated recruit, whose expiratory act is ignorantly discountenanced in order to increase the measurement and the degree of prominence of his chest, is an object for admiration! The Commander-in-Chief (see Mr. Hardy's speech delivered in March, 1878), "was very much struck with the men who had passed the drill; and he is quite sure we have a good class of recruits." And good to look at, in the popular sense, they may be said to be—after they have passed the drill. An examination of their hearts, however, would show, by comparison, how much better they were in reality on the day of enlistment. Now, the best test of the power of a soldier for undergoing physical exertion is to be found in the condition of his heart and lungs under such exertion—in the condition of his circulation: for the lungs are a portion of the circulation. It is quite impossible to judge of a man's powers of endurance by simply looking at him. He may look striking and big-chested, which, if he be a soldier, should incline one to decide unfavourably concerning him beforehand—but, to test the matter, let him—after a march, in marching order, of 10 to 15 miles—be told to throw off his pack and double four hundred yards up an incline, rifle in hand, and carrying 25 to 30 rounds of ammunition; and commence firing at once at a target 300 yards distant. (I do not suggest anything that might not be constantly required of him in time of war.) It will be admitted by those who know, that these are duties to perform which without distress, mobility of the chest, full and unweakened expiratory power, as well as an unimpaired, un-hypertrophied, un-irritable heart, are essential. Suppose we make new recruits practise

such an exercise as the above (leaving out the ball-firing which they have not yet been taught) and beginning with one of about half the difficulty. Let this be done every second or third day, and on the intervening days let them be taught military manœuvres and movements, *instead of sending them to the dilating-sergeant.* This would be a more reasonable system of preparing them for what they will some day have to do than that now obtaining of sending them to practise distressing, exhausting, and unnatural, exercises which they will never be called upon to do. Or suppose that, in view of scepticism—in view of objections on the part of people who regard whatever is as right, and who cannot easily believe that the enormous invaliding of soldiers under two year's service, for heart disease, has been brought about by the evil practices of the drill-field—an experiment be suggested. Hand over any given number, say 200, of new recruits, to be dilated as heretofore by drill-sergeants; and on the same date hand over a similar number to be exercised in such legitimate work for the soldier as I have above suggested, Sections I. and V. being for these a dead letter: and, at the end of three or four months, or more, let the marching powers, the weight-carrying powers, the capability of doubling, of these two bodies of men, be compared:—which cannot be done by looking at them. And not only so, but let their hearts be examined, and a comparison instituted. If it be objected that this would not be a fair test, because the men sent to the drill-sergeant have not yet had the practice of the others—they have merely been having their chests attended to:—I reply that the only inference to be drawn from such an objection is that time has been wasted, *even if the chests had received no damage.* We all know how the British soldier will push on, breathless, and bathed with the cold dews of exhaustion, rather than give in: though more fit to lie down than to march. Is devotion of this kind—or call it what you like—to go for nothing in the consideration of this question? Rather than that the authorities should remain in doubt on this important question, let the experiment I have suggested be tried. I do not abide the issue of it merely on the point of the comparative number of the two bodies of men who would "fall out"—and this would be striking enough, if anything more than child's-play were made the test:—but also on the point of the distress endured by the maltreated section, in their struggle against "giving in."

But, let us say something about these complaints respecting the youth of the recruits joining at Aldershot, into which Mr. Hardy made an inquiry; of which he gave the results in the House of Commons. From what do these complaints arise? From the fact that so great a number of young soldiers are discharged as invalids (after spending months of their short service in hospital) soon after joining. And, without doubt, the younger a recruit is—you may say as a general rule—the more likely is he to be injured by the false system of physical training to which he is now subjected. I dwelt on this point in a former paper. Now, men whose growth is completed, or nearly completed, when they join, are found not to break down in such numbers: and therefore it is not to be wondered at that complaints arise if none but beardless lads are forthcoming. The conclusion jumped to is that these last break down under "military duty" only because they are young! The training, which is injurious to full-grown men, is not suspected of having anything to do with it. I am, certainly, no advocate for boy-soldiers for the British Army. Soldiers should be at least 22 or 23 years old when they go to India, or to other tropical countries: and, of course it must be remembered that a great part of their service will be abroad, and chiefly in hot climates. But supposing it to be possible to keep men at home until they have attained an age at which they may be safely sent to tropical service—and this should be possible—then, on that supposition, I cannot see why we should not be very glad to get healthy, promising, lads of 18 years of age. They will not break down if properly treated: they only break down, as they do, because they are maltreated: maltreated, I know, with the best intentions. This would open up a question, however, which does not concern me now: but I would just add that, in any calling in life, the younger a man joins it, the more likely is he to be fitted for it; or else there is no meaning in such expressions as "He was a man of war," or anything else, "from his youth"—or the like. This being the rule, I, for one, should not care to be allotted the task of showing that the profession of arms is an exception to it. It all depends on how you treat these young and immature men: and on what you expect from them. If you expect them to cover the distance and carry the weight side by side with men many years older, you must expect also to be disappointed. This is not to say that we would not do well to take men young, and treat them rationally. But our present plan is to spend six months giving them hypertrophy and irritability of the heart, as well as emphysema, and other mischief of the lungs, and then, without delay, to apply the pack, straps, and rifle, so as to bring the mischief that has been done to light; to render a man's condition unbearable, drive him to hospital, and thence out of the service, damaged for life—a burden to himself, his friends, and the country. This is literally true, and therefore we cannot be surprised that those in authority consider it, as Mr. Hardy said, "a great misfortune that the men are so young." For such, indeed, it is: but only on account of the "training."

There remains, then, this practical problem for solution:—Medical Officers pass men as recruits for the Service who are expected to become efficient soldiers. But it would appear to be a settled matter in the military mind that the civilian shape won't do in uniform. These men must be altered somehow to fit their new clothes. They must be changed in appearance. They must be provided with an appearance—and a condition of heart—which would have caused their rejection had they presented it when being examined for enlistment:—The practical question, I say, in view of the untold suffering to the men and loss to the Service and State now obtaining, is: Can the required soldierly bearing or presence be attained without prejudice to the well-being of the soldier? The answer to this depends on what the Authorities regard as a soldierly bearing: on whether the dilated, prominent, thorax—for this is the

chief evil—is a *sine quâ non*. To medical men the question is whether a man is efficient or not: whether he can carry his accoutrements; march and double with them; do a hard day's work, such as he might be called on to do in the field—hewing wood, or drawing water, for instance—endure exposure within reasonable limits, and so on; or whether he can not. In their view a soldierly presence presupposes soldierly powers, powers of endurance; capability of "enduring hardness as a good soldier." To military men, to commanding officers of regiments, who look on the outward appearance, the question is a different one: and no wonder; for when a soldier breaks down, at home or on service, they see no more of him. He goes to the hospital, is eventually invalided; or, perhaps, he dies before there has been time to invalid him. The remainder are "well-set-up," as the phrase is, and *look* fit for anything: so did the invalid until *he* broke down:—and so, appearance, attitude, being everything, the civilian is stretched and dilated into the soldier. This, at least, has been the system hitherto. But, if military men will forswear the dilating or "opening" of recruits' chests, and treat them in the light of common sense, then the question I have put may be answered affirmatively. They will have self-contained men to order about, and not puppets who, or rather which, with thumping hearts and disturbed cerebral circulation, with difficulty can give their attention to the orders shouted into their bewildered ears. It will be asked what does my recommendation—or rather what would the following out of my recommendation involve as regards the appearance of the men. It would involve the substitution of an easy, though "attentive" natural, attitude, for the present irksome, sometimes distressing, sometimes exhausting, unnatural, attitude or "position of the soldier" as defined in the drill-book. This point will be again alluded to. Not one of the evil practises discussed would be admitted to form a portion of the attitude of attention. Enough has been said on the *real* merits of the question. It will be well now to justify an alteration in the orders for the "position of the soldier" on the ground of appearance. I take it for granted that the abandonment of the bad points in the training of the recruit is admitted to be called for, according to the representations I have made concerning them. But while it is admitted that there would thereby result a gain in health, that is, efficiency; military men would consider that there would be a loss in the matter of appearance. Now, I do not admit that there would be any loss in this direction. On the contrary there would be—indeed I can say there *must* be—gain. For, if a position or attitude be unnatural, even if it were not injurious—as things unnatural invariably are—it cannot be honestly described as manly, elegant, beautiful, or by any other fine adjective. I have shown it to be unnatural. I am now alluding especially to the dilatation of the chest. It may be striking, but it is a deformity; and as I have shown, an actively injurious one—which cannot be said of most deformities. And the idea that it is not a deformity, but the reverse, now so generally received, is one of those mistaken notions which must be given up. It is a very common notion in the Army, that the possession of an abnormally large and prominent thorax constitutes sufficient qualification to permit of its owner being described as a man of "fine physique." What is thus called "physique" is in reality deformity; in the same way that undue prominence on the opposite side of the chest constitutes another deformity—hunchback. Now, suppose we considered that hunchbacked soldiers would make a formidable array! and suppose also that it was in our power to make them, as we can make the hunch-chests; then, it would be good policy for the Service, the State, and the individual, to make the men hunch-backed instead of hunch-chested, *provided always we could perform the former feat without injuring important organs.* I have shown before that we cannot perform the latter without such injury. The whole thing is distortion—argument too, if you will—but I only wish to suggest, as strongly as I can, that, if in training men to be soldiers natural laws must be departed from, it would be as well to depart from them in a direction, if such could be found, which would not involve quite so much loss to the Service, the State, and the individual soldiers, who are most concerned. On the ground of appearance, then, this puppet-like attitude should be abandoned. It can scarcely be necessary for me to combat the insane idea, which largely prevails nevertheless, that training must be so toilsome and laborious as to be quickly fatiguing, if it is to prove beneficial to the human body: that the more the ligaments of the joints, and the tendons in their neighbourhood, are painfully stretched the better. The strange part of the matter is this: that the very people who hold these false ideas with regard to "training," would be scandalized if, without urgent reason shown, the additional *legitimate* fatigue of, say, 8 or 10 miles extra in the length of a march were imposed on a regiment of soldiers. They regard marching as work, and this so-called training as a kind of beneficient recreation. The soldiers do not take this view, however. "*Setting-up drill*" *is regarded by them with abhorrence, and they would rather do any real hard work than go through this drill, even though the latter should continue only a third of the time of the former.* I make this statement after very careful inquiry—a statement, the truth of which it is, I submit, important that the authorities should ascertain for themselves.

What can be done to remedy the existing evils? I advise that the subject be considered by the military authorities from the commencement:—The surgeon of a recruiting district says—"Here are 100 young men, all thoroughly examined, and found in good health; they ought to prove good soldiers." By which he means that, being sound, they are fit for hard work—able to break stones all day, dig all day long, follow the plough, carry weights within ordinarily reasonable limits; without breaking down. By which he means that he does not anticipate that any of them (much less that many of them) will be sent forward for invaliding within a year or two. Here is the material, then. What is to be done with it? We have seen what has been done with it hitherto: and, to quote the words of the late Dr. Parkes, the result has been that "out of a hundred men discharged (invalided) *under two years' service,* heart and lung disease together constituted, in one year 47-85, and in the other 40-59. "How" he asks, "is this to be accounted for? The

recruits are carefully examined: they have no heart or lung disease: how is it that such diseases are developed during their first two years' service, and indeed, more during the second year than the first?" A very serious question indeed: for there is much hesitation about invaliding men who have only recently joined, and for whose sudden break-down there is no adequate explanation.—What ought to be done with these 100 newly enlisted men? Now, my reply, and recommendation, is this:—Let the military authorities reflect carefully on all the various kinds of real work and real duty that the State is ever likely to demand that the soldier shall perform in times of war and of peace: and having satisfied themselves that they have an exhaustive list before them of everything that the soldier ought to be able to do—according to the arm of the Service to which he belongs—then let them direct that he shall be made to practise all these things. It does not matter what they are, so long as they are things which may be at some time or another required of soldiers in the presence of the enemy, or for the proper performance of their duty at home. It matters not what they are so long as they are real military necessities. No medical objection can be fairly raised to any real military necessity. For instance, in action a man will have to fire his rifle, and use his bayonet; while he will not have to "swell his chest," or remain standing on his toes. Let him, then, practise the former, and not the latter—for the latter are useless even if they were not injurious. Again, the soldier may be required some day to march as much as thirty or forty miles in twenty-four hours, or to go through as much work in the field as that distance represents in work, while he will not be required to swing his arms about, or to double himself in two. Let him be practised at marching, then, until he gives good promise of being able to accomplish long distances and let him eschew all useless antics. He will be called on to run also, and the earlier he begins the practise of it, and pedestrianism, the better. In short, whatever the soldier may be called on to do in the shape of real work, according to the decision of the military authorities, under any circumstances; in all these things let him be practised. If a young soldier break down at such work, then a mistake was made in taking for a soldier a man who cannot do soldiers' work: but at least he cannot be said to have been maltreated, as soldiers are maltreated now. For, he was only sent to practise the legitimate work which he undertook to do; and to do which he was certified fit by a medical man. We are all liable to make mistakes; but, with regard to the pitiful way in which young soldiers break down, I would say—on behalf of the surgeons of the army—that the medical certificate they give does not suppose any maltreatment. It will, of course, be found that the men we pass into the army will not break down as they now do, if they are only treated henceforward rationally: and called upon to do only real work; and to do it in a manner in which it would be considered well done in the field. As regards men yet to join, and who have only quite recently joined, the Service, this is what I contend for:—that they shall not be introduced to the evil practices which I have pointed out: that they shall never have their attention directed to their chests, or to their breathing: that they shall never be told to swell their chests, nor to do extension motions to "open" them. That they shall never be spoken to about the manner of disposing the weight of their bodies; but be allowed to stand as nature meant them to stand. That it shall be impressed firmly, by distinct instructions, on the minds of all drill-sergeants, that no good is attained but, on the contrary, evil, by keeping men long standing still, even though the posture be that known as standing "at ease": for, in this it is not allowed to change from time to time, the limb bearing the weight of the body. There cannot be ease without freedom of action in this particular. That—for the future—*military movements shall, as much as possible, take the place of military standing still.* This is important: more so than it may seem. And finally, that, having been selected as fit to do it, recruits should be called on to do any hard work that is to be done in camp or quarters; and any *legitimate* military excercise; *to the exclusion* of this "training," falsely so called.

That soldiers should possess a manly bearing, and be free from any unsightly trick of attitude, is a proposition in which all must agree. It is scarcely necessary to remark that, in the men selected by the examining surgeons for the army, any such trick or peculiarity can be remedied without injury to the men exhibiting it. I alluded to this before: but it may be well to say a few words further on this point now. Suppose a really well-built strong young fellow, who should make a useful, enduring, soldier, to have the disadvantage of carrying one shoulder lower than the other; or of holding his head badly; or of walking in a shuffling, slovenly manner. Now, such a man does not need, in order to make him presentable on parade, to be maltreated by chest-dilatation, extension motions, &c. One might hesitate about stating so self-evident a proposition, only that there is so much at stake. His gait, his want of symmetry, can be corrected without keeping him standing motionless for an unconscionable time in an attitude shown to be distressing and unnatural. Why not direct his attention to his fault, whatever it be; and not his chest? Need it be said that there is no objection to a drill-sergeant telling a recruit that he holds his shoulders at an unequal height; nor to his directing him to stand straight with his shoulders square? If there be some who think it impossible to make a man look manly and soldierly, in the proper sense of these terms, with such simple directions as these, I tell them they are wrong in so thinking; and I challenge them to show they are right. Surely, the attitude of an individual conscious of his strength is not that which the soldier is now taught to assume. For indeed this latter is a most unstable attitude, as we have seen. When ever did painter delineate, or sculptor model, the figure of an athlete or warrior in anything even remotely approaching the attitude of a soldier at attention? Stability of the body at least should be a first consideration. I feel it is needless to speak further on such a proposition as that men can be improved in appearance without injury to their heart and lungs.—As regards the men already in the Service the matter is not so simple. In spite of the distress occasioned by the drill, it has become an article of their soldierly faith that the drill-book is right; and that so also are the sergeants who administer

its provisions. These last believe that the swelling of the chest is of much advantage every way; and so of the other evils. To them it should be made known that a better light is now thrown on this treatment of soldiers in the drill-field; that, as a matter of fact, a man need not be reminded that he has a chest at all; and that as for "swelling" it, that is all a mistake. The abandonment of the other points shown to be wrong is also called for, as just given. Now, it is certain that if these things were thus frankly avowed, further mischief of the kind in question would be altogtheravoided, though not perhaps immediately. The great majority of the men would quickly forget orders which they ceased to hear repeated: but at the same time there would be some who, from force of habit, would for a time continue to keep the chest distended with air when on parade. The number who would do so might be considerable. Thus, the matter is not so simple as in the case of men not yet joined, or only quite recently joined; who have never heard of these injurious things. Now, for these cases, it is expedient that I should, for the moment, appear to abandon, to go contrary to, my own recommendation; which is, that a man's attention should not be directed to his chest or his breathing at all. Nevertheless, if—after it was made known that the present attitude or position of the soldier was wrong, and that it was now in process of practical modification by the omission of the injurious portions—men were still found who, from force of habit, kept up the dilating of the chest; then it would be necessary in these cases (which would quickly become quite exceptional) to tell the men concerned a good way of getting out of this bad habit. I admit that the advice I have to give involves what is to be deprecated: namely, any directing of the attention of a man to his chest: but it is better to do this, as it will quickly cure the acquired habit, than to leave the man to himself; and any necessity for it will soon die out altogether. I shall formulate the advice and then state why it is, in the circumstances, safe advice. It should be said to him "the best way for you to get out of this habit of keeping your chest swelled—a habit no longer required of you—is to endeavour to keep it in the form it assumes when the breath is out of your body." The safety of this advice lies in the fact that, while expiration is secured, inspiration to the necessary or physiological extent is sure to occur. It is to be regretted, of course, that such an expedient has to be proposed in the interest of men who have already undergone this injurious training—it applies to none other of course:—but it would have a good effect on the comparatively few men whom it would be necessary to advise to adopt it: and, as I said, any necessity for having recourse to it would very soon disappear—in a fortnight or so.

The ideas that have prevailed as to the preparation of the soldier for the work he will have to do, are false ideas; and the invaliding returns prove this: the sooner they are recognized and admitted to be false ideas the better. Thousands of recruits are now joining the Service; the drill season is commencing; and I hasten to lay this paper before the authorities in a more hurried and a less complete form than I could wish, hoping that no time may be lost; and that no delay may be made about abandoning a false system. I beg their attention to this subject, taken in connexion with my former paper (contribution to Etiology of heart-disease in the Army) which appeared in the Army Medical Report for 1876, issued in January 1878; in which it is shown that heart-disease is certainly produced by the training which the recruits undergo.

I conclude by repeating the plain directions by which injury to recruits can be altogether avoided :—

1st.—Start from a basis of real military necessity: sending the men to practise only such work and exercises as they are liable to be called on to do: excluding the artificial evils I have spoken of: namely,

- a. Chest dilatation.
- b. Directing attention to the manner of disposing the weight of the body.
- c. Extension motions for opening chest.

2nd.—Abandon the false idea of human perfection of figure, as it is now supposed to be exemplified by the "position of the soldier": and instruct the drill-sergeant to improve the faulty symmetry of awkward looking men, by directing their attention, not to their chests, but to the fault—whether unequal height of shoulders, head held too much forward—whatever the fault may be.

3rd.—Corrections of the above kind to be made not exclusively when men are standing, but *chiefly* when they are practising military movements and evolutions: for thus the great disadvantage is got over of keeping men long standing still.

4th.—As the soldier is a man whom we select, and whom having selected, we are bound to further prepare, for hard work, let us see that he practises it—making marching and running the chief items in the training—but that he does so under natural and not artificial conditions: under conditions, above all, which allow of no interference with the important functions of the heart and lungs.

These simple directions apply to men already in the Service as well as to recruits now joining and yet to join. To the first, however, it will be necessary to admit that what they had been taught was wrong. I do not see, at least, how such an avowal is to be avoided: for, doubtless, the drill-book will be altered. To any men who were noticed to continue, from force of habit, the dilating of the chest on parade, the advice before given should be offered.

It has been the duty of medical officers to select the men who compose the army; and it has been their duty to watch over the surroundings of these men :—the sanitary condition of their barracks; the ventilation of their rooms; everything, in fact, whereby their health might be secured. But—I think I speak fairly when I say—medical officers have not felt at liberty to follow the soldier into the drill-field: for all that is done there has been supposed to be dictated by military necessity; and military necessity, when real, may not be interfered with. It is, of course, in our province to point out sources of disease or inefficiency from whatever cause arising: but the chest-swelling, and general mal-treatment of the soldier on parade, have been supposed to be eminently beneficial to him! And suspicion that a thing is evil does not readily arise if it be done in the name of good. It is only in this way that I

can account for the fact that an attempt has not, until now, been made to show the evil.

Perhaps another reason why this mischief has not come earlier to light is that heart-disease may be far advanced, and yet give rise to little trouble: the sufferer being even able, though with distress, to go through a considerable amount of exertion. And the gravest forms of heart-disease are known to be long compatible with considerable interest in, and enjoyment of life. I recall just now two cases which I shall give briefly. In a boy of 10 years, whose heart I examined when a student, with the view of learning the normal sounds, I heard what I could not at the time appreciate; but what indicated aortic regurgitant disease. Knowing that something was wrong, but without knowing the gravity of the case, I brought it to the notice of a physician who told me what it was. The boy grew, continued his education, and never complained until many years later: and he could not believe that there was anything the matter with him. To compensate for the valvular deficiency the heart hypertrophied enormously, and maintained the circulation until he was 21 years of age. Thus, for 11 years from the date at which the disease was discovered, and discovered accidentally, he lived in comparative comfort, was able to enjoy school-boy life, though of course advised to avoid active exercise; and never complained except during the last year or so, when the great force of the cardiac impulse troubled him, and produced occasional bleeding from the nose. The other case was that of a soldier of nearly 21 years' service, who came to hospital complaining of breathlessness; was examined by me, was found to have aortic valve disease, was admitted, and died in 9 days. He said on arrival that he could not understand what had come over him, that he had felt very well until two days before, when he became breathless. He had not been in hospital for years, and never for any heart affection. Nevertheless, this disease *must* have been of long-standing: for his heart was about three times its proper weight. It weighed thirty-three ounces and a half: and two segments of the aortic valves were as if curled up short, and thickened. There was also calcareous degeneration of the coats of the ascending and transverse portions of the arch of the aorta. I need scarcely say that I do not cite these cases for the reading of medical men, who know these things. I trust military men, who may help towards having something done, will read this paper: and I give these two cases only to show them that much mischief may be present in men who look all right, who look "striking" in the eyes of the inspecting military officer as he walks along the line. A pain in the bowels, a cold in the head, a sprained ankle, a blistered foot—any of these things will decide a man to go to hospital; but how many men are suffering from heart disease—I allude chiefly to hypertrophy and irritability of the organ; for, happily, valvular affections, though very frequent, do not form the prominent feature which the former affections do in the army—who never complain. I hit upon the right word when I used the expression "*untold* suffering." Let those young men be remembered who, after an army experience of one or two years, in peace time, are invalided as being useless; having spent months of their short service in hospital: and who are sent back to their friends damaged for life in the name of military necessity. All acknowledge real military necessity: it is because I have been able to show that the practices herein considered cannot be properly described by that name, that I have undertaken to condemn them as false, unnatural, and injurious. Is it not due to the Service and to the public that the necessary changes should be made without delay?

KING'S ROAD, GUERNSEY,
April 15th, 1878.

POSTSCRIPT.

I think it well to add a few lines to what has preceded, lest, owing to the hurried manner in which this paper has been prepared, misconception on one or two points should arise.

Firstly, it may possibly be objected to my having spoken of the order for the disposition of the weight of the body as involving an unnatural attitude, that this is not so; inasmuch as any position or attitude the body is capable of assuming cannot be said to be unnatural. This would be hyper-criticism; but it would be fair, if I have not made it sufficiently plain that I was not dealing with a momentary attitude, or an attitude the immediate preliminary to movement; but with the *standing* position of the soldier; the position in which he is *kept*. A momentary attitude, no matter what, could have been no mark for criticism at all. We know that recruits *are kept standing in this attitude*, and that so also are old soldiers of 20 years' service, when at "setting-up" drill: and this in accordance with the terms of the drill-book (Sec. 1). It was in this sense that I called the "position of the soldier" unnatural.

Secondly, it may seem bold to have attempted to set aside altogether the portions of the two sections of the drill-book (Secs. 1. and 5.) with which I dealt. It may be thought that it would have met the case to say merely that extension motions are *over*-practised by the men, and that if the time were limited, say to ten seconds at a time for the swinging of the arms "as quickly as possible," and such like recommendations for the other extension motions, no harm would be done. And similarly of the standing attitude of the soldier at attention; if a time-limit were fixed for it, which, I must remark is impossible in practice, all would be well. In short it may be said that if I had proposed a time-limit in respect of the standing position of the soldier, and of the extension motions, instead of advocating the total abolition of the latter, and the removal of the evils of the former, I would have proposed something, if not more practical, at least more practicable. No time-limit is given in the drill-book, and I should be sorry to suggest any such thing:—Of course men must stand erect while they are being told what they are to do, and this may take a considerable time: they must stand in an attitude of attention. I do not want this to be different from what it is now, except in respect of chest-swelling, and the thing which, as shown, is an additional incentive to chest-swelling; namely, the order directing that the fore part of the feet is to bear the chief portion of the weight of the body. I recognize, of course, that it is not possible for military officers to address men, much less to put men in motion, who are standing anyhow. There must be attention and uniformity. All I ask for is that the attention and uniformity shall not include the two objectionable things just mentioned. And concerning extension motions, a time-limit in regard to most of them would be practically useless: for instance, the "first practice," containing the direction to "force" the arms backwards, and to "elevate the neck and chest as much as possible"—a bad order, meant to open the chest. Then, again, the stooping extension motion—which I regret having styled the apoplectic amusement, for the matter is serious enough—what time-limit will any one venture to suggest for that? I did not adopt the course I have indicated because to have done so would have been equivalent to pointing out the right road, and then deliberately recommending that the wrong road should be taken. These are the things which commit the recruit to the discretion of the drill-sergeant, the things which—with the bodily suffering and mental irritation induced by them—have caused him before now to run his tormentor round the parade-ground at the point of the bayonet; *and which the men believe to be the chief cause of the desertion of recruits from the Army*: a belief in which I concur. The recommendation which I have made—that soldiers should be practised in soldiers' work, meaning real, legitimate, work, and real military exercises, and in no other—is a safe recommendation. Some may say it is insufficient, even with the gymnasium which all approve. I only ask, will not the sterno-clavicular and shoulder joints, and the muscles attached to and arising from the scapulæ, be amply brought into play by bayonet exercise, fencing, swimming, digging, cricketing, etc., without the swinging of the arms in the manner ordered in the drill book? When some *work* is found to require this swinging, then it will be time to practise it.

I have to acknowledge much want of system in the arrangement of this paper; and, in parts of it, much perhaps unnecessary verbosity. But the case is a good one: and if I thought it needed a more careful statement in order to ensure for it the attention it demands, I would not hesitate to re-write it. If, however, the truth of the matter is allowed I shall not object to criticism of the manner in which it is stated.

F. A. D.

A Paper concerning the Relation of Aortic Disease, of Aortic Aneurism, and of destructive Lung-lesions, in the Army, to the Artificial Chest-dilatation which forms a portion of the physical training of the Men.

In the following remarks an endeavour will be made to connect the setting-up drill, which soldiers undergo—and which was treated of in former papers—with the diseases named in the heading. I consider that such a connexion can be established. Setting-up drill being, as I have already proved, capable of inducing morbid conditions of the heart itself, it is reasonable to suppose that other parts of the circulation beside the central organ, may be adversely affected by it: and I think enough can be advanced towards convicting this drill of being an important determining cause of the above-named diseases in the Army, to make what I have to say worthy of consideration. I do not believe that the Medical Department regards as satisfactory the present state of our knowledge of the etiology of the circulatory diseases of military life: in which term I include the destructive lung affections—viewing the lungs as that expanded portion of the circulation in which the venous blood is spread out, as it were, for aëration: and I am sure that anything deserving the name of a contribution to the subject will be willingly received. For, if there be anything special producing the great proportion of these diseases which is found in the Army, it is of the greatest importance that that special thing should be pointed out. And particularly so if the cause be removable. The view here put forward is that there is in the Army a special cause which will largely account for the excess of circulatory diseases; and that that cause, as shown in a preceding paper, is removable. But I would remark that even if it should be concluded that I have established no connexion whatever between the setting-up drill and the diseases named in the heading,—that the attempt to establish that connexion has proved a failure, I nevertheless claim that action be taken upon what I have previously shown: namely, that setting-up-drill produces, *per se*, and independently of dress and accoutrements, soldier's irritable heart and hypertrophy of the organ. And if the case can be made no better against it, it is surely good enough already. It will, at least, be allowed that a hypertrophied or a dilated heart cannot be good for its aorta, or for the lungs. The intention of this paper is very limited. It is not a paper on aortic disease, aortic aneurism, and destructive lung lesions, in the army. Its object is merely to show the manner in which the prevalence of these diseases is so greatly favoured by the artificial chest dilatation, which forms a portion of the physical training of the men:—

Taking first, and taking together, aortic disease and aneurism of the aorta—the lung affections to be taken briefly afterwards—it should be said that the question of the causation of these affections in the Army has received much attention. In two consecutive years, between April 1867, and April 1869, no fewer than thirty-six cases of aortic aneurism were treated at Netley Hospital. Two principal causation-views have been advanced in order to account for the remarkable prevalence of this disease (aortic disease and its common sequel aneurism) among soldiers: and these views may be summed up, I think fairly, thus. One is that the excess of the disease is due to the constriction of the chest, which the soldier suffers in his tight dress and accoutrements—the causes in fact which have been regarded as productive of the excess of heart-disease. The other view is that constitutional syphilis is at the root of the mischief, producing disease in and weakening of the aortic coats. I think I am right in stating that those who have advocated the one of these causation-views do not set aside the other: but, while admitting both, they attach a special importance to the causation-view of their choice, and regard the other as being of comparatively minor importance. Rheumatism and alcoholism are put in the back-ground, and, I think, for the young soldiers, properly so. Those who favor the obstruction-by-tight-clothing view admit, of course, that an aorta weakened by syphilitic, or other disease, will give way before the increased blood-pressure of hypertrophy, more readily than a sound vessel: and those who regard preceding disease of the aortic coats as a *sine quâ non* (at least for the majority of cases) grant, in return, that the hypertrophy produced by tight clothing or other external constriction, is of much assistance in determining the occurrence of aneurism. But these latter cling to the opinion that arterial *disease* almost necessarily precedes any giving way of the vessel-wall—certainly so (I take it) when it is a question of a sacculated aneurism. Thus, then, the two causation-views, although opposed, help each other out to explain the great prevalence of aneurism in the Army. So to put it—there is plenty of syphilis and plenty of tight-clothing, and therefore plenty of aneurism. And there the matter rests. But it should not be allowed to rest there.

Now, the constriction-by-tight-clothing view of the causation of aneurism, would appear to be favoured by such a consideration as the following. Let us say a civilian of about the soldier's age contracts a hard chancre. He has secondary symptoms in due course—cutaneous eruption, or throat ulceration. He consults a surgeon, but not before the signs of constitutional taint have shown themselves. Suppose the treatment he now undergoes to be judicious; does the Surgeon who prescribes it contemplate as a likely, or, I might almost say, a possible eventuality, the death of this man by aortic aneurism as a consequence of his hard chancre? He certainly cannot think that aortic disease is already set up: but does he contemplate aortic disease for his patient at all? Suppose the treatment to be injudicious, or ineffectively carried out:—or suppose no treatment whatever. Then, of all the places in which constitutional syphilis may locally declare itself, may find a site, does it occur to the mind that the aortic coats of this civilian are in danger of being attacked? No: the practitioner looks for syphilitic disease in its most horrible outward forms; he looks for absorption of bone, and even for grave diseases of the nervous system,

not excluding hemiplegia, paraplegia, ataxia, and insanity, before he contemplates, if he contemplate at all, the dire misfortune of aortic disease for his patient. Now, the soldier, as has often been said, has far more chance of early and appropriate treatment than the civilian—at least, than the civilian of the class of life from which the soldier, as a rule, comes. Nevertheless, he must run a risk of aortic disease and aneurism which the civilian does not run. Such a consideration, I say, *appears* to favour the causation-view adopted by Professor Maclean and by Mr Myers—the writer of the "Alexander" Prize Essay on heart disease in the Army. I mean that it appears to favour that view as against the syphilitic-view—if I may so call it.

On the other hand, however, we have the unquestionable fact that, in the Army, syphilis and aortic aneurism are intimately associated. In a very able paper, to be found in the Army Medical Report for 1873, Mr. Welch proved this association: and there is no doubt that what Mr. Welch describes as syphilitic disease of the aortic coats *is* syphilitic disease. He showed from the pathological records at Netley that "Aneurismal dilatations are associated with syphilis to the extent of 60 per cent, and without it (they are found) to the extent of 4·4 per cent., and that aortic disease tending to dilatation is very rare otherwise than with it." Concluding the paragraph I am quoting he says—"It seems an incontrovertible deduction that syphilis must be put down as a very potent cause in the production of aortic disease and its sequel aneurism." I remember that this view did not find much favour in the eyes of the members of the Medico-Chirurgical Society before whom, some years ago now, Mr. Welch read a paper embodying it. It would have been surprising indeed if it did not meet with hostile criticism at the hands of civilian medical men. These latter see plenty of syphilis, and very little aneurism traceable to it: but, while they considered it too great a jump from a hard chancre to aneurism of the aorta, they did not, if I recall correctly the discussion on Mr. Welch's propositions, call his pathological investigations into question!

These, then, are the two antagonistic views—Syphilis on the one side—tight clothing on the other. Mr. Welch demonstrates syphilitic disease in the aortic walls; but his opponents, civil and military, cannot get over the fact that in civil life the aorta escapes. Now, of these two causation-views, I regard that which attributes the great excess of aneurism in the army to syphilis as the more correct. In other words I consider that constitutional syphilis is more to blame for aortic aneurism in the army than tight-clothing. I concur also, of course, in the proposition that hypertrophy, if brought about by tight clothing and accoutrements (as it may be) will tend to produce aneurism: for this hypertrophy would be the immediate cause, perhaps, of the dilatation of that portion of the vessel which had been most weakened by preceding disease (syphilitic or other): which dilatation, I may add, might not have taken place, even in a diseased vessel, under ordinary blood-pressure. But, with Mr. Welch, I regard *preceding* disease of the aortic coats as essential, in almost all cases, to the production of aneurism: for post-mortem examination supports this opinion. And I must add—although

I advance no reason just now for the statement—that the idea of a healthy aorta having a sacculated aneurism (this form largely predominates) formed in it simply by the distending influence of blood sent forward by a hypertrophied left ventricle, does not commend itself to my mind. It cannot be denied of course that such a thing is possible. But, as I said, with Mr. Welch, I consider preceding disease of the aortic coats an essential in almost all cases for the occurrence of aneurism.

It will be plain now that what we want to arrive at is an explanation of the association of syphilis with aneurism in the army. We must admit this demonstrated association, but we admit it unwillingly, because we find no such association in civil life. And here I must point out that the constriction-by-tight-clothing view does not afford this explanation. Indeed, it has never been contended that it does. It has been contended that tight-clothing and accoutrements by inducing hypertrophy, may produce aneurism of the aorta: and it has been contended that *if* the vessel be diseased their influence will be all the more likely to have this result. But it has never been contended that the faulty clothing of the soldier affords any explanation of the remarkable association of syphilis and aortic aneurism in the army. In what way, then, may this association be satisfactorily explained? Why does syphilis so frequently select the aorta of the soldier, and pass over that of the civilian? In answering these questions I hope to show the relation in which aortic disease stands to the artificial chest-dilatation of the drill-field. I do not say that chest-dilatation can directly produce disease in the aorta, but I do submit that, in the presence of constitutional syphilis, it can *determine*, as I shall endeavour to show, *the development of syphilitic disease in this unwonted site.*

The argument—I trust it will be allowed to deserve the name—is founded on the relation which exists between structure and function: on the fact that any considerable alteration in the amount of function required of a part is necessarily followed by some alteration in the structure of that part. And this is true of a gland, of a muscle, of a ligament, of the skin, when all the co-existing conditions are physiological. Now, I propose to show that the demand upon the functional qualities of the aorta (if I may be allowed the expression) is very much greater during the chest-drill than it is when the chest-movements of inspiration and expiration are being normally performed—unhindered by the attention being directed to them. If this drill can entail hypertrophy of the heart, as I have shown, what may it entail on the aorta?

To avoid repetition I must refer the reader to the paragraphs of my first paper on this drill-question, which describe the manner in which the balance between the pulmonary and systemic circulations is disturbed by the drill: asking his attention especially to the fact that, in consequence of the pulmonary congestion quickly induced by it, the left ventricle receives a deficient supply of blood: deficient both in quantity and in degree of aëration. This results in a considerable rise in frequency of the pulse, which, the body being motionless, cannot be accounted for as being due to the exercise being undergone. The ventricle, having less to contract upon contracts more frequently—for the system requires

the blood. But the supply to the ventricle through the pulmonary veins being lessened—the rise in the pulse-rate being the measure of this lessening—and the condition of the chest which brings about obstruction in the lungs being kept up—expiration in abeyance—it follows that there is less blood in the arterial system than usual; and this is defective in degree of aëration. Now, the aorta must accommodate itself to this abnormal state of things. Above all arteries it is the artery most likely to be injured (the word will not be taken literally) by the withdrawal of accustomed support within it. This elastic vessel is called upon to maintain due pressure on its diminished contents: and, of course, it does maintain pressure on the blood passing through it. But the pressure is insufficient; and its insufficiency duly to maintain the pulse-wave is revealed in the small and jerky radial pulse found in almost every recruit drawn up in the regulation attitude. While I would guard against its being concluded from what I have said that I conceive the diminution in the quantity of blood in the systemic arteries to be anything very remarkable, I nevertheless press the importance of the point under consideration, viz.: diminished support, from deficient blood-supply, in the systemic arteries. The muscularity of all smaller arteries should, however, be mentioned as tending to lessen the degree of this diminished support within the aorta. This muscularity comes into play, aiding in the production of the characteristic pulse already noticed.

Not only, however, is the aorta thus placed at a disadvantage in regard to its function of exercising due pressure on its contents—a disadvantage the extent of which will be appreciated when the special anatomical characters of this vessel are remembered—but, being thus placed, it receives from the ventricle blood which has been ejected more abruptly, and, as hypertrophy is induced, more forcibly, than under normal conditions. A necessary consequence, then, of the chest-dilatation of the drill-field is an unusual and abnormal demand upon the functional qualities of the aorta. This demand is in truth both unusual and abnormal; and cannot be compared with that arising as a consequence of natural active exercise or work, during which the movements of respiration are unimpeded. A moment's reflection will cause this point to be conceded: for, although it may be said, truly, that very active exercise, continued long enough to cause great breathlessness, can bring about a disturbance of the balance of the two circulations: yet it must occur to the objector that the origin of the congestion of the lungs and right side of the heart in the latter case, is not, primarily, the same as it is in the chest-drill—the expiratory act being unhindered, with all that that signifies. I am tempted to repeat points already dealt with: but will only add that setting-up drill is not active exercise; requesting a reference to the 11th and 12th paragraphs of "A Contribution to the Etiology of Heart-disease in the Army," (Appendix No. VI. of Army Medical Report for 1876), without which reference the argument may, I fear, appear somewhat incomplete to the reader.

I might, perhaps, at this point safely ask the reader to allow that the adverse influences above spoken of are capable of occasionally producing aneurism of the aorta. Indeed, the occurrence of aneurism is at present put down to less potent causes. I shall not ask so much, however. I do not even ask that these influences shall of themselves be allowed to be sufficient to produce disease of the aortic coats. All I shall contend for is that these adverse influences are—in as much as they involve increased and abnormal functional activity for the aorta—certain to originate an alteration in the nutrition of the coats of the vessel, tending to tissue-growth: and that this tissue-growth will be most active in those parts of the vessel most experiencing unaccustomed functional strain—whether this increased strain arise from diminished support within the aorta, or from the powerful contractions of a hypertrophied left ventricle; or eventually from both of these causes combined. I am within my logical right in that contention. I will allow, too, that the intention of this tissue-growth is beneficent in the circumstances. Alas! of course, for the circumstances. I hope the reader will admit that the conditions described are sufficient to produce intersticial thickening—tissue-growth—in the aorta. Let him remember that embarrassment of the heart is certainly brought about by the holding in check of the act of expiration, and let him reflect on the consequences of this to the aorta, not merely as regards irregular or excited cardiac action, but as regards the partially-checked passage of blood towards the left side through the pulmonary veins. To arrive at the cause which originates this tissue-growth,—damaging to the elasticity of the vessel, even if it never became degenerate—is the end of this inquiry. I hold that the artificial chest-dilatation, now taught, long taught, to the men, produces this growth in the first instance; and I think enough has been said to gain the assent of the reader to this opinion.

We have now got as far as a beneficent tissue-growth in the aorta, and shall here repeat the question—Why does syphilis so frequently select the aorta of the soldier and pass over that of the civilian. The answer is—because that of the soldier is the seat of tissue-growth: because it is the seat of active nutritive changes, such as are comparable neither with those ordinarily taking place, nor with those of growth from youth to maturity. The vascular supply of the coats of the aorta is increased and tissue-formation is active. Now, my position is that the presence of this tissue-growth in the aortic walls can, if the subject of it contract constitutional syphilis, determine the selection by the syphilitic poison, of the aortic walls for its local manifestation—that an abnormal growth of normal tissue-elements constitutes a weak point in the economy in which blood poisons are likely to set up disease.

The relation in which aortic disease in the Army, as well as its common sequel aneurism, stands to the chest-dilatation which the men undergo, will now be apparent. I trust the view put forward will be regarded as helping to explain the striking association of aortic disease and aortic aneurism with syphilis. It is certain that there is some hitherto unexplained reason why syphilis should select the aorta of the soldier as it does—some reason why aneurism in the army should be associated with this disease "to the extent of 60 per cent., and" be found "without it to the extent of 4·4 per cent., aortic disease tending

to dilatation being very rare otherwise than with it." The question for the reader is—Is chest-drill to blame? If he decide in the negative, then let him not merely declare himself unconvinced: let him seek to reveal a cause or causes more likely than the obstruction to the circulation described in my first paper (published in Blue Book for 1876) to affect the nutrition of the aortic walls, and to determine the site of development of the syphilitic poison: for *something* determines it. I mean that it is not sufficient, it is not satisfactory, to be told that, given constitutional syphilis, there is no organ or tissue safe from its ravages. This is true, no doubt: but instead of opening discussion such a smooth saying checks it. We want to account for the frequency of syphilitic disease in the aorta after a more definite fashion than that.

But if the reader withhold his assent to the view advanced, it becomes necessary in some way to account for the tissue-growth of which I have spoken. And I commend to him, with this end in view, the following extract from Mr. Welch's valuable paper (A.M. Report for 1873) already alluded to. Indeed the whole paper should be carefully read: on which account I shall refrain from quoting many passages which favour the argument now offered. "The evidence "furnished by the records of this hospital (Netley) clearly shows that "it is impossible in pathology to separate the arterial disease from the "dilatation known as aneurism, the former being the precursor of the "latter: and this is seen, not only in those examples coming under the "category of aneurism, and classified as such, but also in those cases "of disease elucidated only *post-mortem*, the cause of death being "otherwise than the arterial lesion, but in which the lesion is present, "though not sufficiently advanced or pronounced to give it a maximum "importance in the determination of death. From the fibrous "formation between the internal and middle coats to the aneurism is a "connected chain, which commencing in a tissue-growth abnormal in "origin, leads, through a degeneration of the formed material, to "impairment of the resiliency of the arterial walls, and so under "internal blood-pressure to dilatation." (A very important foot-note occurs here which is too long to transcribe.) "That the degradation "of the vessel coats is no mere result of age-changes is clear from the "death-age of the individual cases adduced in this series: that a "tissue-growth precedes the degradation is unquestionable; hence the "important point in *etiology* is to find out the *causation of the growth*, "*the conditions which originate the germination of the deeper layers of the* "*internal and contiguous layers of the middle coats of the aortic walls*, for "the subsequent fatty and caseous degeneration to which it is liable, "and which brings it under the category of atheroma, is a phase "common to most abnormal growths, and some normal structures." The italics occur in the original. It is plain that Mr. Welch thinks, or thought when he wrote the above, that the causation of the growth had yet to be discovered.

There is another paragraph in Mr. Welch's paper which is well calculated to stimulate inquiry. It is the following:—"That the "syphilitic virus, as an exciting agency of the end-arteritis is generally "dispersed in the Service, equally as is aneurism, will be seen by "referring to my table on the relative prevalence of secondary disease "throughout the Army, in the Blue Book 1872, p. 389. The end-"arteritis is shown at page 384 Blue Book, 1870, to be the most "commonly observed sequel of infection, and I am inclined to think "that, although not limited to any one period of virus-evolution, it is "generally one of the earlier produced lesions of the internal "structures, and this is in consonance with the comparative absence of "gummatous nodules in the viscera of the cases of aneurism adduced, "the vascular lesion killing before the so-called tertiary lesions had "had time to become developed in the internal organs." Non-military surgeons regard this, of course, as very astounding doctrine; and although it is true for the soldier, they refuse to believe it. As I said, it is, for them, too great a jump (as it should be for us) from a hard chancre to aortic aneurism. Something, they think, must be in the back-ground: and they are right. More justice would have been done by the Medico-Chirurgical Society to Mr. Welch's valuable researches in the post-mortem room, if some such attempt as I now make had been made by him to show cause why syphilis should select the aorta of the soldier. There would at least have been another factor in the case with which his critics must needs count.

It may further tend to stimulate inquiry if I quote also the following from Mr. Myers' prize-essay—"To this (disease of the aortic coats) I "shall now proceed to allude, and in the first place may state my "belief that very few specimens of thoracic aortas in a perfectly "normal condition are to be found in soldiers who have died after "eight or ten years' service." That is a remarkable, if a somewhat vague, statement. I do not like to put a construction upon it such as it may not fairly bear; but perhaps Mr. Myers means by "very few" 30 or 40 per cent. I cannot help thinking that would be an exaggeration. He must have had some grounds for making that statement, however: and, taking it in conjunction with Mr. Welch's carefully-drawn conclusions from post-mortem examination, it is deserving of consideration. But suppose we say that 50 per cent. would meet Mr. Myers' view when he says "very few specimens of perfectly normal thoracic aortas are to be found in soldiers who have died after eight or ten years' service"—even then some very generally acting cause must be at work. Would not the idea of 50 per cent. of more or less diseased aortæ being found *post-mortem* in men of the most unhealthy trades and habits be scouted as utterly improbable; more especially if the death-age were limited to 32 years of age. Most soldiers have completed "8 to 10 years' service" long before that age. He attributes the abnormal conditions of the vessel to two causes—syphilis, and mechanical obstruction to the circulation, meaning that produced by tight clothing and accoutrements.

For an account of the pathological appearances I must refer the reader to Mr. Welch's paper: noting here, however, one point insisted upon by him: namely, that "the condition of the vessel at the onset "of the disease is not that of dilatation, but on the contrary it is "thickened with its calibre encroached on."

I beg to repeat the words—thickened with its calibre encroached on:—Let that be read in connexion with what I have previously shown—that the systemic arteries contain during the chest-drill a less than the normal amount of blood, the aorta having to accommodate itself to this unusual state of things (see *Ante*). If altered function means alteration in structure, surely alteration in structure will occur here: for the aorta is not a muscular but an elastic vessel.—If the surgeons of the Army will not have it that the drill is to blame in the manner I have tried to point out, there is certainly ample inducement in the paragraphs I have quoted, from Mr. Welch's paper and Mr. Myers' Book, to make them set about finding out what *is* to blame. The matter should not be allowed to rest. I do not, of course, claim to have proved anything in this paper. I have contended for a reasonable view, giving the reasons. A view supplementary to, and giving force to, Mr. Welch's opinions. And, practically, it is a safe view: for it only seeks further to condemn what is now admitted to be wrong—the chest-dilatation—the persistent ignoring of the act of expiration—taught in the drill field.

Now, although I am not concerned to support the syphilitic origin of aortic aneurism apart from some explanation of this origin such as I have given, yet I cannot help, before concluding this portion of the subject, alluding here to a piece of criticism, adverse to Mr. Welch's views, to which some weight appears to be attached. It has been said that among all the cases of aneurism brought forward by him there was no example of syphilitic heart-disease. But the very point of Mr. Welch's contention is here lost sight of. He was careful to state that the early death-age often precluded, and also that the rapidity with which the vascular lesion killed, often precluded the possibility of the so-called tertiary lesions becoming developed in the internal organs. (See the whole paragraph already quoted.) Mr. Welch's cases showed extension of syphilitic aortic disease to the aortic valves, and in one instance to the mitral, but his critics want gummatous nodules in the muscular substance of the heart at a period long antecedent to their development in more usual sites—liver or testicles. To take him to task, to account, according to his view, for the comparative infrequency in the Army of arterial disease in vessels of less calibre than the aorta, would have been more to the point. It might have had the effect of raising the issue which I now raise. But allowance must be made for Mr. Welch's critics as well as for Mr. Welch—there being a factor in the case ignored by both one and the other. The members of the Medico-Chirurgical Society objected to being told that "this (aortic) end-arteritis is the most commonly "observed sequel of (syphilitic) infection," because it did not at all accord with their civilian experience, and Mr. Welch did not tell them why it did not so accord. He gave them pathological facts: but we only like to admit facts to be facts when we see reason for the admission.

2.—It is time, however, to turn to the destructive lung diseases of the army. Will the chest-drill help to account for their prevalence? I shall not have much to say on this point that might not be inferred from what has preceded. I said in my first paper that pathological states may be expected to commence when physiological conditions are departed from. This should be true of the important organs of respiration. I showed that the heart-embarrassment begins by lung-embarrassment; and that the latter begins in congestion of the pulmonary capillaries, due to interference with the act of expiration. How this periodically-repeated congestion may affect the walls of the functional blood-vessels; how the elastic parenchyma of the lungs may be affected by this congestion: how the *nutrition* of the lung parenchyma itself may be influenced by the increased and uncalled for function thrown upon it; while at the same time the air-cells are over-distended by forced inspiration, and (for want of due expiration) the air in the ultimate air-vesicles is not duly changed—are points into which it is not necessary for me again to enter. But I contend here that the increased functional call we impose on the elastic structure of the lungs, in the drill-field, results in intersticial changes tending to hypertrophy of that elastic structure. To quote a few lines from my first paper: "Hypertrophy of the elastic parenchyma "of the lungs might be expected to occur on the *ubi stimulus ibi fluxus* "principle: but if it does it will not be compensatory, and tending to "the restitution of expiratory power; but will cause pressure upon, "stretching of, and partial obliteration of, the functional blood-"vessels—the pulmonary capillaries."

But, it will be said, this is a long way off from destructive lung-lesions: a long way from the various forms of phthisis pulmonalis which prove fatal, some very quickly, some slowly; but which admittedly cause a great mortality, and a greater invaliding. Well—be it so. For I have not ventured to say that chest-swelling can at once produce organic disease of the lungs, ending in hæmoptysis and disorganization. But let us see what *has* been advanced to account for the destructive lung-lesions of the army. While there are destructive lung diseases in the world we shall have them in the army; but to what cause have we hitherto been putting down the great excess of these lesions in carefully selected soldiers? To impure barrack-air. "This" (writes Dr. Parkes) "is the conclusion to which the Sanitary Commissioners for the army "came in their celebrated report, after assigning all probable influence "to exposure on duty, intemperance, and a somewhat faulty diet"—Impure barrack-air. Dr. Parkes agrees in this conclusion. He gives a table in his work on Hygiene showing that out of every 100 deaths 35·77 are caused by destructive lung lesions for the army at large. But, he says, "there is an astonishingly disproportionate number of cases of tubercular disease in the Foot-Guards, which is still as remarkable as it was twenty years ago." And Dr. Parkes goes on to say—"It may "be safely concluded that the larger part of the men invalided will "shortly die, and their deaths will swell the mortality from tuberculosis "of the civil population. The table shows in fact"—continues Dr. Parkes—"that there must be a large amount of phthisis *generated* "in the army, and in the Foot-Guards it would seem to be nearly four "times as much as among the civil male population of 25 to 45 years

"of age." The air breathed by the Foot-Guards must be exceptionally bad. That is a fair deduction. There is no other reason given why the Foot-Guards should specially suffer. They are selected in a very particular manner for a very particular corps. But I say that the deduction is not only fair—it is accurate. I do not say that their barrack-rooms are less airy and roomy than those of less favoured corps; why should they be? But the air they (as a body of men) breathe must be exceptionally bad. The amount of chest-drill required of the Foot-Guards may not exceed that required of other corps as regards the number of hours of its daily practise, but it is carried out with exceptional strictness: the proportion of men who succeed in evading the drill-sergeant's orders being less considerable than in the line generally. I beg permission to quote shortly from my first paper. "The inspiration, then, a deep one—which the recruit "takes at the word of command—produces physiologically an "acceleration of the movement of blood from the large veins on the "exterior of the chest towards the heart, which movement of blood "towards the heart *had been retarded by the previously-occurring and* "*duly-performed expiration*. Now, as expiration is not, after the word "of command, again duly performed, and as the position of the thorax "is one of deep inspiration and remains so—the diaphragm doing "little to diminish the size of it, and the elastic recoil of the lungs and "chest-walls being overcome by voluntary effort, does it not follow "that, in a given time, a larger quantity of venous blood will have "passed into the right side of the heart than would have passed if the "check, or retardation, which the expiratory movement (properly "performed), exercises, had been imposed? I do not quite contend "for a *vis a fronte*; if that were established for a moment it would "soon be disestablished. The right ventricle contracts vigorously, "but the blood it drives forward for aëration cannot part with as "much carbonic acid, or receive as much oxygen, as if respiratory "movements were normally succeeding each other all the time. The "degree in which the exhalation of carbonic acid suffers hindrance is "in direct proportion to the impurity (CO_2) of the air in the ultimate "air-vesicles. This air is only changed (if it can be spoken of as being "changed) by the law of diffusion of gases; but in the absence of "efficient expiratory movements this law is at a considerable dis-"advantage for the purpose required, &c." . . . . . Now, so far, we are not out of accord with the Sanitary Commissioners for the army. Impure air has some of the blame to bear, but not altogether the barrack-room air. There is dyspnœa, distress, and even exhaustion, due to imperfect respiration in the *open air*. I grant, of course, that sleeping in a close barrack-room is bad for health. It is not only bad for the men undergoing this drill, but it is worse for them on this account than it would otherwise be. But if, with the Sanitary Commissioners for the army, we must blame barrack-room air for the excessive prevalence of destructive lung-lesions, shall we pay no heed to the dyspnœa, distress, and exhaustion, of the drill-field, due to the imperfect respiration taught there? Is the imperfect respiration which even induces grave disturbance of the circulation less injurious than that which does not? Must we take care that the men have pure air to breathe, but also take care that they are first rendered more or less unfit to breathe it?

But I do not merely contend that the impurity of the air in the ultimate air-cells (whether owing to insufficient ventilation of barrack-rooms, or to the holding in check of the act of expiration, or whether owing to one and the other) is sufficient of itself to account for the mischief that ensues. I contend for something more specific; namely, that nutritive hypertrophic changes are induced in the lung-parenchyma of many of the men who have to make more than usual efforts to satisfy the drill-sergeant's demand for thoracic prominence. This altered amount of function will induce altered structure in the direction of *growth*. It is trite that the persistence of functional derangement is certain to induce organic change. I might say organic disease. I shall not say organic disease: but how easily may organic change become organic disease, (in lung structure especially) in the presence of blood poisons—syphilitic, rheumatic, or alcoholic. Will not the predisposition, also, be greater to low inflammatory attacks from ordinary causes? Will not the common causes of bronchitis and pneumonia be more likely, under the conditions I have endeavoured to describe, to produce these diseases, with their too frequent sequelæ in military life—destructive lung disease?

In truth, we have hitherto been putting down the circulatory diseases of the army, constituting together the disability of the army which produces the bulk of the mortality and invaliding, to totally inadequate causes.

Let it not be said that I claim too much for this especial cause of loss to the Service and the State. Let it not be said that I try to prove too much, or that if what I say be correct the mischief ought to be much more universal even than it is: I have elsewhere stated that very many, especially the older recruits, do not appear to suffer: that there are many whose figure requires a minimum of chest-distension to satisfy the drill-sergeant: that those who do suffer suffer by no means equally. Further, that very many of those who suffer even considerably (I mean, in whom a condition of much dyspnœa is induced while at recruit's drill, in the *standing* attitude of the soldier at attention) recover sufficiently to make no complaint whatever. And further, other conditions for the degeneration of tissue-growth, if it occur, into destructive disease of the same, may be wanting: the body has great powers of recovery. Every man does not get secondary syphilis. And if every man got it, every man could not get it at the critical time. Let the critic who thinks I spoil my case by proving too much, undertake to explain the causes of the mortality and invaliding, for circulatory diseases (including lung destructive lesions) of the Foot Guards. Would he be rash enough to leave out of account the system of setting up-drill? I think I may fairly say that I have not overstated the matter.

In conclusion I wish to add—although it in no way affects what has preceded—that in India there is, *compared with at home*, little seen of

circulatory diseases. There are several reasons. An examination is held of all men about to proceed on foreign service. By it many are kept back who have the "soldier's heart," but who have not complained of it: as well as many who had been admitted to hospital for cardiac trouble, with breathlessness on slight exertion. This preliminary examination is very necessary. But it is strange that it should be so, in the case of young soldiers who have not served abroad before: stranger still that these latter should furnish the greater number of rejections! This examination is conducted with regard chiefly to the state of the thoracic organs—with regard to the capacity for active exertion. Beyond the matter of age, it is not an examination as to special fitness for India. The *temperament* of the candidate is not allowed to weigh. At enlistment it is as well known as at any other time, that service in hot climates is pretty sure to be the lot of the recruit. The re-examination is, however, necessary, as in the meantime he may have "broken down under drill!"

Then, again, the men who do come out to India are not required to do so much setting-up drill. There is less constraint generally, mental as well as bodily. The conditions imposed by necessity are more recognized in this climate, and many useless things are, as in a campaign, left undone. And yet, how stands the case of the European troops in India, as regards the matter in hand? The Report of the Sanitary Commissioner with the Government of India, for the year 1876, happens to be before me. According to the Sanitary Commissioner the number of deaths from heart-disease, and destructive lung disease, taken together was, in that year, 123. That is, 61 from heart-disease, and 62 from phthisis pulmonalis. In the same year there were 134 deaths from cholera:—these figures are for the whole of India. There is no argument, of course, intended, in putting these figures in contrast. I merely so put them just to draw attention to the considerable loss by circulatory diseases even in India. We think it, and indeed it is, appalling to lose 134 British Soldiers in one year from cholera; but to lose 123 in the same period from heart and destructive lung disease, even with all our precautions and examinations, seems less terrible. Yet, in reality, the loss to the European Army in India by destructive lung-disease *alone* (excluding heart-affections) was, in the year 1876, greater than the loss, of 134 men, by cholera. The Sanitary Commissioner does not give the number of admissions to hospital for heart diseases, but he does give the admissions under the heading phthisis pulmonalis. They were 468. Now, my experience of the service has been—and if it be not the general experience I trust I shall be put right—that to return a man as suffering from phthisis pulmonalis is a thing that is never done without long consideration of the case. It is, therefore, very unlikely that the diagnosis will be often incorrect. But let us suppose that only 300 of the 468 were really cases of phthisis pulmonalis. We are told that of these 62 died in the country. What became of the 238 remaining? They were, of course, invalided to England. Considering the large deduction, of 168, already made for possible error of diagnosis, it would be great hopefulness to conclude that 38 returned to duty, or to light duty. (I am putting the case most favourably). So that 200 would be finally discharged in England, to die of phthisis as "civil population:" no matter how long they lived, the men, after the final invaliding, are lost to the service. The loss of European Soldiers in 1876, by cholera, by no means equalled the loss by destructive lung disease occuring in India in the same period. But if we add the loss of 61, who died in India, in that year, of heart-disease; and take into account the invaliding under this head, (the deaths alone almost equal the deaths by cholera) we find that our loss of 134 lives by cholera in 1876 is insignificant compared with our loss by circulatory diseases in the same year.

It may be justly said, of course, that I have gratuitously compared figures which have no relation to each other. I admit this. But I compared them for a special purpose; and I do not consider the comparison worthless:—being in India, I felt bound to make *some* allusion to the matter as it affects India. But, it is at home that this disability of the army, which I desire to see mitigated, and which can be mitigated, reigns. The time has now come when the teaching of physiology can no longer be disregarded in this training of the soldier. But it is sad to reflect that only by a long experience of the pathological consequences have we arrived at the conviction that physiological laws cannot be outraged with impunity.

ATTOCK, PUNJAB,
June, 1881.

To Medical Library from the author

OBSERVATIONS ON MEAT
(*BUTCHERS' MEAT*),

IN RELATION TO

THE CHANGES TO WHICH IT IS LIABLE UNDER DIFFERENT CIRCUMSTANCES.

BY JOHN DAVY, M.D., F.R.S. L. & E., &c.

From the Proceedings of the Royal Society of Edinburgh, March 19, 1866.

Animal food is of so much importance, in relation to our wants as to diet, that I have been induced to make some experiments on it, with the hope of obtaining useful results. These I now submit to the Society, imperfect as they are, trusting that they may not prove altogether useless, and that they may lead to further inquiry.

1. *Of Degree of Temperature as modifying Change.*

It is well known how rapidly meat undergoes the putrefactive change in the height of summer, and in tropical climates at all seasons; and, on the contrary, how long it may be kept free from putridity during our winter, and more especially at the freezing temperature, and degrees of temperature approaching the freezing,— in this, as in the preceding instance, fully exposed to the air of ordinary atmospheric humidity.

In the comparative trials I have made in each season, for the sake of precision, the meat used has been divided into two portions,— one, suspended by a thread, has been fully exposed to the air of the room; the other has been suspended in a receiver over a little water,—the receiver, so covered as to admit air, and yet prevent rapid desiccation by evaporation.

In one experiment on portions of lamb, made at a temperature varying from 60° to 65° of Fahr., between the 11th and 12th of August, the results were strikingly different. The portion fully exposed to the air lost weight rapidly, and soon became dry and hard, without acquiring any putrid taint; whilst the other, on the contrary, softened, and for most part actually liquified, at the same time becoming extremely putrid.* I have mentioned these results in a note, in a paper published in the last volume of the Society's Transactions,† and in the same note have adverted to the fact of the perfect preservation of the meat during the like time and temperature over water in vacuo.

In a second trial made in winter, a portion weighing 141·1 grs., exposed freely to the air, became dry and hard in twenty-three days, viz., from the 27th of October to the 19th of November, the thermometer in the room averaging about 55°. During this time it lost by evaporation 95·6 grs., or 67·7 per cent.; and it lost no more from further exposure.

Another portion of the same meat, weighing 74·5 grs., suspended over water lightly covered, retained during the same time much of its humidity, and shortly became covered with a delicate, white filamentous growth of the mucednous kind, not unlike very fine hair.‡ It emitted the peculiar smell of mould, and the water beneath had a taint of the same. On the 15th of December it was reduced to 26·6 grs., or had lost 65·2 per cent. The delicate white fibres were somewhat shrunken; the upper moiety had become darker; cut into, the mouldiness was found to be superficial; the interior, of a darkened colour, was of increased translucency; its muscular fasiculi were distinct; their structure so little altered, that when moistened with dilute acetic acid their striæ were seen well

* The droppings from the putrifying meat have had some resemblance to chyme, being found to consist of a fluid coagulable by heat, in which were suspended, as seen with a high magnifying power, innumerable granules, some fibres, and some minute crystals.

† Transactions, vol. xxiv. p. 137.

‡ This may help to account for what is stated of a body long buried, which, after forty-three years, was found as reported almost entirely covered with hair. According to the narrative: "The cover of the coffin having been removed, the whole corpse appeared perfectly resembling the human shape, exhibiting the eyes, nose, mouth, ears, and all the other parts, but from the very crown of the head to the sole of the feet covered over with hair, long and much curled." A specimen of this hair-like substance was considered worthy of a place in the repository of Gresham College. (See *Phil. Trans.* abridged, vol. ii. p. 490.)

defined. Underneath, in the water, there was a little white sediment, which was found to consist chiefly of cells (spores) thrown off from the mildewed surface. Evaporated to dryness, the residue weighed only ·4 gr. Replaced over fresh water, this water, in three days, had become slightly turbid from spores suspended in it, and had acquired the peculiar smell of mould.* The portion of meat was now freely exposed to the air; it soon shrunk and became hard; and when it sustained no further loss from evaporation it was reduced to 21 grs., a loss of 71·6 per cent.—a part of which loss, it may be presumed, was owing to the vegetable growth.

In the paper already referred to, I have mentioned that dried meat does not attract the flesh-fly, only the putrid in progress of deliquescence, when it affords a fit nidus for the larvæ of this fly, and for their nutriment. I may further remark that the temperature at which the flesh-fly loses its activity, and is no longer seen (one of about 50°), is also that at which the deliquescent process of putrefaction ceases and the mould-growth takes its place.

2. *Of a Moist or Vapourous state of Atmosphere as modifying change.*

The influence of warmth and moisture of atmosphere in promoting the putrid decomposition of animal matter is an established fact. It is well known that within the tropics, especially in littoral regions where the thermometer ranges between 78° and 83° or 84°, and the atmosphere is commonly damp, the difference between the moistened and dry bulb seldom exceeding 5° or 6°, putrefaction is so rapid that meat cannot be kept more than a few hours without acquiring a putrid taint. When, however, the air is very dry, as in Nubia and the African deserts, then the putrefactive process is very much arrested, though the temperature may be high. At Malta a wind occasionally prevails,—a south-west wind, coming from Africa,—which, in the summer season, I have known as high as 105°, and so dry that the difference between the moistened and dry-bulb thermometer has been as much as 30°. The atmosphere of Nubia is somewhat of the same character; and its quality, as to the checking of the putrefactive change, is well shown by a passage in

* Spores were found also on the inner surface of the glass covers. When thrown off, it may be inferred that they are readily diffused in currents of air.

a very charming book by a lady,—Lady Duff Gordon's "Letters from Egypt," 1863–65; writing from that country, Nubia, she remarks: "Fancy that meat kept ten and fourteen days under a sun which I was forced to cover my head before! In Cairo you must cook your meat in two days; in Alexandria as soon as killed, and the sun is nothing there. But in Nubia I walked till I wore out my shoes and roasted my feet: and I was as dry as a chip in Nubia and as low down as Kiné, below Thebes some way; after, it altered, and, though cold, I perspired again." I may mention another striking example. In the early spring of 1826 I visited the Greek island of Ipsara, a little more than two years after it had been invaded and devastated by a merciless Turkish force.* We found it a desert, the town in ruins, only one of the inhabitants remaining, who served as our guide, all the rest, excepting those who escaped in their ships, or were captured and enslaved, having been massacred. On one side of the island, exposed to the south-east wind, the moist sirocco, on a spot where the carnage had been greatest, only bleached bones were to be seen; whilst on the other and opposite side, exposed to the north, to the dry Etesian wind, at a battery called Fetellio, which had been heroically defended, we found two or three hundred bodies still remaining, lying as they fell, and so little were they changed that our companion was able, though their faces were blackened and shrunk, to recognise each individual by his features. They had become, as it were, natural mummies; their clothes—for they were all clad—had apparently suffered little decay; and their hair, except that it was a little bleached, showed its natural colour.

Whether such a checking of putrefaction is owing to a rapid desiccation of the surface and a retardation of the entrance and penetration of oxygen, or to other less obvious causes, may be a question. I am disposed to consider it owing to the former, inasmuch as putrefaction always begins at the surface,† and from the

* This was in June 1824, about midsummer.

† It is well known to cooks, that whilst the outer surface of meat, such as venison, may be offensively tainted, the inner portion may be comparatively sweet and fit for use, especially if the deer, as soon as shot, has, according to the practice of the skilled forester, been well blooded. It need hardly be remarked, that if the blood is allowed to remain, it is itself a source of putrefaction, owing to the oxygen which it retains. The butcher, guided by

circumstance that desiccating substances, such as quicklime, prevent putrefaction.*

3. *Of Cooking as Modifying Change.*

That the boiling or roasting of meat thoroughly enables it to be kept longer, even at a temperature and moist state of atmosphere most favourable to putrefaction, is well known to the housewife. From the few trials I have made, the process appears to arrest the putrefactive change, and to favour other changes with the production of mould or mildew.

The following is an instance:—On the 11th of July 1864, a portion of well-boiled mutton was suspended in a receiver, and covered with a plate of glass not air-tight. It weighed 82·2 grs. On the 20th of the same month it was reduced in weight to 74·3 grs., and on the 7th of August to 65·6 grs. It now had a slight smell, not agreeable, not putrid. It seemed drier, and was covered with mould of various colours, mostly white. Cut into, its interior had the smell of decaying cheese. The muscular fasciculi were distinct; and, with the aid of dilute acetic acid, their striated structure was seen. It was near, and only near, the surface, that the vegetable growth was visible. Four months later, it weighed 49·4 grs. It was drier, and had become very much darker; its colour was a very dark brown. Examined in the following December, *i.e.*, after seventeen months, some mildew was found on its surface. It had an ammoniacal and disagreeable smell, like that of rotten cheese, and it cut like such cheese. When broken, not cut, it was found

experience, is most careful in expelling as much blood as possible without delay from his slaughtered animals.

* I may refer, in proof of the above, to the results of experiments given in vol. ii. of my Researches, published in 1838, confirmed by others in a later vol., that of 1863. In the former I have quoted an instance from the "Philosophical Transactions, Abridged," vol. ix., of the futility of burying the carcasses of diseased cattle with quicklime. Yet quicklime is still ordered to be used in the interment of such carcasses, but with the addition of some disinfectant. Such a procedure, no doubt, will vastly delay the decomposition of the bodies, and prevent the formation of offensive gases. Carbolic acid, one of the disinfectants recommended, has the advantage, I find, of being repulsive to dogs. A portion of meat moistened with this acid was refused by three hungry dogs.

friable. The muscular fasciculi still retained their form, and, with dilute acetic acid, showed the striated marking, with an increase of translucency. From another experiment of the same kind on boiled mutton, begun on the 13th of August 1864, and continued to the 11th December of the present year, like results were obtained

Blood, too, I find, after having been subjected to the boiling temperature, has its tendency to putrefy, arrested, like muscle, and that from keeping it undergoes somewhat similar changes. I may mention one instance:—On the 6th of September 1864, a portion of fowl's blood, just after it had coagulated, was boiled for several hours. The vial holding it, on its cooling, was corked, but not so tightly as to prevent the admission of air. It was placed in a room where there was no fire in winter, and, with the exception of being under cover, the temperature to which it was exposed differed but little from that of the open air. Examined on the 14th of December 1865, it was found moderately dry, for most part of a brick-red colour, partially whitish. It had an ammoniacal odour, no putrid odour. Under the microscope, it was seen to consist chiefly of amorphous matter, of cells like the spores of mucedo, and of blood corpuscles,—these, except in form and size, but little altered;—no crystals were visible. It imparted to water only a very faint, just perceptible, brownish hue, as seen after filtration and separation of suspended particles. The water had a strong alkaline reaction, but was almost tasteless.

A clot of blood—to mention another instance—which had been boiled only ten minutes, kept the same time, offered nearly the same results. It escaped the putrefactive change; mould formed on it, which, after more than a year, was of various colours, bright red, white, and black—changes of colour, it may be conjectured, owing to the different states of the vegetation.

Is the change which meat and blood undergo after exposure to a boiling temperature, as described, in any way analogous to that which vegetables experience when converted into peat?—a conversion which appears to take place only at a comparatively low temperature—below that favouring rapid decomposition; for I am not aware of any peat-formation having ever yet been discovered in

progress within the tropics or in any locality the mean annual temperature of which is above 60° of Fahr.

4. *On the Influence of Sulphurous Acid and Acetic Acid in Arresting Putrefaction.*

From time to time I have made some other experiments on meats chiefly with a view to their preservation. The first instituted were with sulphurous acid, of which I have given an account in a volume of "Researches," published in 1839. The second were on vinegar, the results of which are there also described.* The sulphurous acid had previously been employed in arresting the fermentation of the more delicate white wines. I found it to arrest the putrefaction equally well of animal and vegetable substances, and so preserving them as to render them not unfit for use as human food. Trials with vinegar and dilute acetic acid gave somewhat similar results, so far as the immediate arrest of putrefaction was concerned; but it did not, like the sulphurous acid, so alter the character of the animal or vegetable matter as to prevent ulterior change on the removal of the acid by washing with water.†

If the subject under consideration, that of the preservation of meat, is always, from an economical point of view, deserving of attention, is it not especially so at a time such as the present, when, owing to the cattle plague, there is a danger of a stinted supply, at a greatly enhanced price?

* Researches Anatom. and Physiol. vol. i.

† Since the experiments above referred to were made, others have been tried, the results, too, of which I may briefly describe.

On the 9th of September, a fresh parr, laid open and eviscerated, was suspended by a thread in a bottle in which was a little vinegar, the parr not in contact with the acid. Another parr, similarly prepared, was moistened with vinegar and wrapped in blotting-paper, also moistened with the acid. Thus enclosed, it was placed in an ale-glass and covered with a tumbler. After eight days the suspended parr was found well preserved: it had not the slightest unpleasant smell; its surface was not distinctly acid to the taste, and its teeth retained their sharpness. The other parr was also free from any unpleasant smell, but was softening in places; the bones were quite soft. After ten days the body of the first parr was found detached from softening, and had fallen into the acid, the head remaining suspended, and it was still free from any unpleasant smell, as was also the softened body. The parr in paper was little changed; it showed no marks of putridity.

From the Author

(For private circulation only.)

ROYAL UNITED SERVICE INSTITUTION.

Friday, June 22, 1883.

T. CRAWFORD, Esq., M.D., Director-General Army Medical Department, in the Chair.

ON MILITARY HYGIENE.

By F. S. B. François de Chaumont, M.D., F.R.S., Professor of Military Hygiene, Army Medical School, Netley.

It is now thirteen years since I had the honour of addressing this Institution on the subject of military hygiene, taking for subject-matter the questions: 1st. The Ventilation of Barracks and Hospitals; and 2nd. The Ration of the Soldier. At that time only thirteen years had elapsed from the time of the sitting of the Royal Commission at the close of the Crimean War, an event which proved to be the turning point in the health history of armies. We were then (June, 1870) on the eve of the severest European struggle since the Napoleonic wars of the beginning of the century,—little as the fact was suspected by many who ought to have known better,—and since that time there has been a succession of wars of greater or less importance politically, but fraught with much instruction from a hygienic point of view. Those in which our troops have been directly engaged have been the Ashanti War of 1873, the wars in South Africa, in Zululand and the Transvaal, in 1877–80, the Affghan Campaigns of 1878–79 and the Egyptian Campaign of 1882. With a certain amount of similarity in the circumstances, there were important individual differences which gave a peculiar character to each of these struggles. The first, the Ashanti War, was carried on in one of the most unhealthy even of tropical regions, and the losses by disease were in consequence greatly in excess of the losses by the hand of the enemy, in spite of the rapidity with which the campaign was accomplished. The South African wars on the other hand were carried on in a sub-tropical climate, where the normal conditions are healthy, but where the exigencies of war gave rise to considerable sickness. The Affghan wars were accomplished in a hill climate in the neighbourhood of the tropics, but under circumstances of peculiarity and difficulty, aggravated by the invasion of tropical disease. The Egyptian Campaign was in a country not exactly tropical, but in close proximity to the hottest region of the earth; a country, too, of which our troops had a grave experience in former times as regards health, and of which they retained down to recent times an unhappy reminiscence in the shape of ophthalmia.

In the Army generally very considerable changes have taken place. It has, in the first place, become emphatically a *young* army, and it is gradually assuming a character wholly different from that in which those began their military career, who like myself have reached the half-century of life. In the second place the foreign service of the soldier is now almost entirely tropical or sub-tropical, the Colonies situated in the temperate zones providing mainly for their own defence. A third circumstance, which has an important bearing upon the health of the troops, is the change in the organization of the Medical Department, the abolition of the regimental system, and the substitution of the unification system in its stead. I propose in the first place to consider briefly the general improvement which may be traced in the condition of the soldier, as shown by the statistics of sickness, death and invaliding in the general returns at home and abroad; and afterwards to review shortly the results in the different campaigns above referred to. It is probably in the recollection of those who have given attention to the subject that the sickness an. death-rate of our troops at every station was in former times most excessive, at all times exceeding those of civilians of the same ages, even where the actual circumstances seemed in favour of the soldier. If we cast a glance at the older returns we shall find a condition of things that must excite surprise in any one becoming acquainted with them for the first time, and the simplicity of the means by which the improvement of the present day has been effected would astonish not less, did we not know how the plainest objects are often unnoted from their being actually too near for our vision, just as the most difficult names to find on a map are not those which are in the smallest letters, but those whose letters are exceptionally large and spread over a wide area. In the able abstract by Surgeon-General Balfour, F.R.S., which is to be found in the second volume of the Army Medical Department Reports, that for 1860, we have the following data:—

	Admissions per 1,000.	Deaths per 1,000.
Guards (before 1837)	(no record)	21·6
„ (after 1837)	862	20·4
Infantry of the line (after 1837)	1,044	17·9

In 1860 the following were the ratios:—

	Admissions per 1,000.	Deaths per 1,000.
Guards	737	9·48
Infantry	904	9·95

In 1870 the following were the ratios:—

	Admissions per 1,000.	Deaths per 1,000.
Guards	627	9·16
Infantry	707	7·89

In 1880 the ratios were:—

	Admissions per 1,000.	Deaths per 1,000.
Guards	1,004	7·50
Infantry	944	5·79

The total ratio for the Army at home for the ten years, 1870–79, was:—

Admissions ...... 809 Deaths ...... 8·18

And for 1880:—

Admissions ...... 896 Deaths ...... 6·83

There has been thus a steadily diminishing rate of deaths, that is of serious disease. The rate of diminution has been:—

Rate of 1860 was 44 per cent. less than that before 1854.
„ 1870 „ 26 „ „ of 1860.
„ 1880 „ 36 „ „ of 1870.

The general death-rate of the Army at home for the ten years 1870–79 was 56 per cent. below that before 1854, and the rate for 1880 was 62 per cent. below it.

If we now look at the classes of disease which have been thus diminished, we shall find that they are especially those which have been distinctly recognized as preventible by sanitarians, viz., destructive diseases of the lungs and typhoid (or enteric) fever. With regard to the former, we find that the ratio of death from destructive lung disease (included under the head of phthisis or consumption) was, in the period 1830–36, 7·83 per 1,000, and in 1837–46, 7·89, or practically the same, showing no tendency to diminish; and those numbers did not include the deaths from inflammatory disease of the lungs. Thus in the year 1830–36 there were annually in the Foot Guards 10·8 deaths per 1,000 from phthisis, but 3·3 also from other lung diseases, making a total of 14·1. Now the total deaths from *all* diseases in 1880 were only 6·83 per 1,000, or 12 per cent. less that the consumption deaths alone thirty years ago, and 37 per cent. less than the consumption rate of the Foot Guards. The total consumption death-rate of the Army in 1880 was under 2 per 1,000, or 75 per cent. less than the pre-Crimean rate. This eminent improvement has been conclusively proved to be the result of the improved condition of ventilation in the soldiers' sleeping rooms, which has been gradually effected since 1858. But that it is not yet sufficient we know from two sources. In the first place the amount of air contemplated by the Barrack Commissioners is much smaller than what is now recognized as necessary for the best health and efficiency. But the Commissioners showed wisdom in restricting themselves to requirements which there was a reasonable hope of carrying out, rather than in insisting upon conditions which would certainly at the time have been looked upon as chimerical. The amount contemplated and now given is 1,200 cubic feet per head per hour; but the amount desired in the present day is just three times that, 3,600 cubic feet, or one cubic foot per second. In the second place, if we compare the phthisis death-rate of the Army with that of civil life, we find it to be still in excess. For that purpose we must take not only the death-rate, but also the ratio of invaliding, for by this the Army gets rid of cases which would otherwise prove fatal, but which go in reality to swell the death-rate among civilians. Of course the effect upon the civil death-rate is hardly appreciable, but the difference that their removal makes on the Army rates is very considerable. Thus in 1880, ~~4·15 per~~ 1,000 were invalided for this class of disease, and this added to 1·98 of deaths gives a total rate of 6·13 per 1,000 lost to the Army from one class of disease. If now we compare these figures with the civil returns, we find that the total deaths on the general male population is only *two-thirds* of this, that London shows only 75 per cent. of it, and that the worst districts of England (excluding hospitals) show only 81 per cent. of it, or less than *five-sixths* of the Army rate. The healthiest districts of England, on the other hand, show only 1·96 per 1,000, or 68 per cent. less than the Army rate. Now, when we consider that the Army is a group of selected lives, and that the consumptive recruits who are rejected fall back into the ranks of civil life, it is clear that there is still something that keeps up this serious drain upon the Service. This something I have no hesitation in saying, is the still imperfectly ventilated barrack room. It is just quarter of a century since the great change was begun which has been so happily fruitful in saving to the State and health to the soldier; but much still remains to be done. I think it is now time to revise again the soldier's accommodation and to improve it so far as to bring his condition somewhat more abreast of modern sanitary science. The thing of course could be easily done, for it is merely a question of money, but I am afraid the getting of the money will prove the difficulty. The improvement of barrack rooms is less striking than a battle or a brilliant campaign, but its good effects would be more certain and lasting, and the cost not greater. Could we double the space the soldier has in barracks, even without increasing the means of ventilation, an enormous benefit would be obtained, but if we could do both, as we should certainly do if the opportunity were given, there is no reason why the loss from phthisis should be more than in the healthiest district in England. This would be a saving of about 350 men per annum in the home Army alone, and if we take the usual estimate of the value of a soldier at 100*l*. this would be a saving per annum of 35,000*l*. This capitalised at only twenty years' purchase would be 700,000*l*., which would go a long way in providing the additional accommodation desired. But we should be doing more than this, for we should be thus increasing the number of healthy males destined to be fathers of healthy progeny, and the Army would thus do its part in gradually stamping out consumption in our midst.

Another important group of diseases is the so-called zymotic or febrile group. Among these we find, as the most important in this country, typhus fever, typhoid (or enteric) fever, and small-pox, with

cholera which is only an occasional invader. Of these we may say that typhus has ceased in times of peace to be a matter of anxiety. Two conditions must be present together to give rise to or favour the propagation of this disease, viz., crowding and destitution. Neither of these is now likely to be present among our soldiers, therefore the origination of typhus among them is rendered practically impossible. But the disease once begun is exceedingly contagious, and can be easily communicated from person to person, so that in a serious epidemic no class is free from the danger. The general improvement, however, in the well-being of the poorer classes has to a large extent abolished the causes of typhus in late years, and the health of the soldier has reaped the benefit. In time of war it is a disease to be always feared. It caused immense loss to our troops in the close of the last and the beginning of the present century; it severely scourged the French Army during the retreat from Leipzig; it was one of our direst foes in the Crimea, and it committed great ravages on both sides during the last Russo-Turkish War. It has sometimes been remarked as a curious fact that there was no typhus to speak of during the siege of Metz, but it need not be wondered at, for the compression was not nearly so great as has been the case in other instances, and there was no true destitution; facts in their result which ought to be taken into consideration in estimating the wisdom or good faith shown in the surrender of that important position, a surrender which hopelessly compromised the fortunes of the French in that terrible conflict.

As regards small-pox, the disease has been practically stamped out in the Army at home. During 1880 there were only three cases of the disease in 84,000 men, and the ratio for years back has been exceedingly small, although from the inconvenient form of the returns it is difficult to state the exact number of cases, mixed up as they are with other eruptive disorders. We may, however, confidently say that the vaccination and re-vaccination of the troops has been so perfectly performed as to reduce the chance of their taking small-pox to a minimum. Among our foreign stations we had similarly small numbers in 1880, the only cases occurring being in Gibraltar, Malta, China, and India, 11 in all and 2 deaths; or a total ratio at home and abroad of less than 9 cases per 100,000, and little over 1 death per 100,000 of strength.

Cholera.—This formidable disease is endemic only in the Delta of the Ganges and Brahmaputra, and perhaps also in that of the Irrawaddy. Its causes are still obscure, as are also to some extent the modes of its spread. We know, however, that it does spread from time to time beyond its usual focus, and that no country is safe from its invasion. We have good proof that hygienic measures, such as the provision of pure water in plenty, care about the removal of excreta and general cleanliness, are powerful means of combating this dreadful enemy. What can be done, when those hygienic means are carried out uniformly and well in a community, may be seen by the diminution of cholera deaths in the Army at home in the last epidemic—that of 1866. In former epidemics the troops had suffered severely like the rest of the community, but in 1866 there were only 13 deaths out of 70,000 men, and only 17 cases of the disease, which is a very fatal one; the usual mortality being about 2 out of 3 (or 20 out of 30); but in the above group it was even more, 2·3 out of 3 (or 23 out of 30). The above death-rate was little over one-third of the general cholera death-rate of the kingdom in that year. Since that time so much has been done, both in civil and military communities, to improve the sewerage and water supply, that I think it is not too much to say, that even if cholera did reach our shores, it would in all probability fail to establish a foothold.

The remaining group of fevers, namely, enteric (or typhoid) fever, is of much more importance to us than any of the former. Cholera is a mere casual visitor, but typhoid is always with us; typhus arises under conditions that are quickly recognised, and may be rapidly altered, but typhoid is a disease of insidious character, the cause of which often lurks unsuspected; against small-pox we have a safe defence and sure prevention, but we have none such against typhoid. This disease kills in the United Kingdom some 10,000 to 11,000 every year, the total number being about 108,000 for the first ten years (1869–78) after the disease was separated from other fevers in the Registrar-General's returns. It is a disease which is peculiarly a disease of bad sanitation, arising from either air or water being poisoned by the emanations from excreta, undergoing decomposition in confined spaces. It has often shown itself more a disease of the rich than of the poor, and this for two reasons, it is believed. Firstly, because water-closets and such conveniences have been more generally *within* the houses of the better classes, whilst the poorer more generally resorted to places outside. Sewer air therefore would be less likely in the latter case to get in from ill-ventilated and untrapped drains. Sinks also, and fixed baths are other channels of access for sewer air. The second reason has been thought to be (although this is less certain) the mode of living of the wealthier classes, especially the use of richer and more plentiful food. There is, however, no reason for any one taking typhoid fever, if proper precautions be adopted; drain and soil pipes may be properly trapped and ventilated, sinks and bath-wastes may deliver harmlessly in the open air; and the water supply may be effectually protected from all contamination. In former days we lost a number of men from fever, but this has been gradually diminished. In ten years, 1837–46, there were 620 admissions, and 17 deaths per 10,000 of strength for continued fever; in the eight years ending 1867, there were only 220 admissions, and 5 deaths per 10,000; in 1871 the ratios were only 9·2 and 2·5 respectively. In the four years ending 1875, the deaths were 3·7 per 10,000; in the five years ending 1880, the deaths were 3 per 10,000, and in 1880, 2·6. If we compare this with the condition of things in civil life, we find that the death-rate, among male adults of the same ages as soldiers, is 10 per 10,000, or nearly four times the Army death-rate. If we look again at the proportion that the typhoid deaths bear to the total deaths, we find that in the Army they are only 4 per cent. of all deaths, whilst in civil life, at the same ages, they are

9·6 per cent., or nearly two and a-half times as great. This result, following as it does, on the marked improvements which have been carried out in the sewerage and water-supply of barracks at home, is a strong corroboration of the view which connects typhoid fever with imperfect sewerage arrangements and contaminated water.

Of the other diseases which cause mortality among troops at home, there is one group that attracts attention, and that is, the diseases of the heart and great vessels. This question has been carefully investigated by various medical officers, but particularly by Inspector-General Lawson (retired), by Professor Maclean, of the Army Medical School, by Surgeon-Major Myers of the Scots Guards, and by the late Professor Parkes. It is certainly a startling thing to find even now that this class of diseases stands second in the list of mortality among soldiers, and causes more than one-seventh of all deaths. Dr. Lawson calculated some years ago that aortic aneurism (a sack-like dilatation of the great artery of the body) was *eleven* times more frequent among soldiers than among civilians. Mr. Myers showed that the deaths and invaliding from heart disease in the Foot Guards as compared with those in the Metropolitan Police were as follows:—

		Died per 1,000.		Invalided per 1,000.
Foot Guards	....	0·80	....	3·20
Police	....	0·29	....	1·37

They were also greater in the Army than in the Navy to the extent of 35 per cent. of deaths and 50 per cent. of invaliding. Compared with the general population (males between 15 and 44 years of age), Dr. Lawson showed that the deaths from heart disease were 60 per cent. more numerous in the Army than in civil life. In 1880 there died of diseases of the heart and vessels in the Army at home 81 soldiers, there were invalided and discharged from the Service 390, and there were constantly sick 115, so that there were 586 men whose service was lost to the State, or about two-thirds of a battalion. It has further been shown that although the loss is large in all arms it varies with the particular arm. Thus, in the infantry of the line the total loss by deaths is 1·11 per 1,000 (1867–71, for since that time details are wanting); in the Foot Guards, 1·36; in the cavalry, 1·44; and in the artillery, 2·25 per 1,000. Or, taking the infantry of the line as unity, we have 25 per cent. more in the Foot Guards, 30 per cent. more in the cavalry, and 105 per cent. more in the artillery. Considering that the ratio in the infantry is more than double that of civil life, there must be some sufficient cause for this remarkable amount of disease. In civil life rheumatic fever and disease of the kidneys are the two most common causes of heart disease, but neither of these can operate much in the Army. Besides, Dr. Parkes showed that, of the young soldiers invalided in the two first years of service, diseases of the circulation formed 14·23 per cent. of all causes of invaliding. Neither syphilis, nor intemperance, nor excessive smoking, although these might be contributory causes, could account sufficiently for the condition of things observed. After an inquiry of an exhaustive character it was narrowed down to one set of causes, viz., the work the soldier had to do, and the unfavourable circumstances in which he had to do it. All who are conversant with the subject will admit that the life of the soldier in time of peace is by no means a hard one, that is, he works on the average less than the ordinary labourer or artizan of the classes from which he is taken. Thus, if we take the average daily work of a labourer at a little over 300 foot-tons, the soldier does not do more than about two-thirds to three-fourths of this; or, say, a labourer or artizan may do 2,000 foot-tons a week, whilst a soldier probably does 1,400 to 1,500. Indeed his rations, if he depended entirely on them, would not provide sufficient energy for more than this. But in the work of the soldier we have an element which does not always enter into the work of the artizan or labourer, and that is, the increased velocity of work producing *strain*. The effects of strain in mechanics is well known to all engineers, and the human frame suffers much in the same way as beams, girders, and mechanical engines do. Men who suffer most in this are the artillery, whose drill with their special arm calls for very sudden and violent exertion; next come the cavalry, who are also called upon for sudden exertion, although in a less degree; and, lastly, the infantry, who have to undergo rapid work, such as in doubling, which tells upon the men. Now this is exactly the order in which the mortality from heart and vessel diseases shows itself—the artillery being highest and the infantry lowest. As those exertions, however, are part of the work of the soldier they cannot be altogether avoided, but the conditions under which they are done may certainly be improved, and the necessary evils lessened. Now, formerly the soldier performed his work under very adverse circumstances, particularly in the matter of his accoutrements and his clothing. The effects of the old knapsack and cross-belts are too well-known to require repetition here, and much, if not quite all, of the objections have been removed by the introduction of the new equipments. But it is not the same with the clothing, which is still too tight across the chest, at the neck, and round the armpits, tending not only to impede movements, but to distress the man. No civilian would consent to work under the conditions imposed upon the soldier, whilst the sailor of the Royal Navy, who is exposed to at least as hard and sudden work, suffers in a much less degree than his Army brother. Looking to the statistics of successive periods we find that in 1867–71 (5 years) the deaths from diseases of the circulation were in the Army 1·462 per 1,000, and that they formed 16·71 per cent. of all deaths; in 9 years, 1872–80, the deaths were 1·17 per 1,000, and 14·8 per cent. of all deaths; and in the last three years of this period, 1878–80, the deaths were 0·65 per 1,000, and 10·4 per cent. of all deaths. In 1880 the deaths were 0·52 per 1,000, and 9·1 of all deaths. We have here a progressive improvement, no doubt due in large measure to the better arrangements for the carriage of the necessaries. But when we consider that the loss in the Army is still above that in civil life, and that the soldier's life is a selected one, no recruit being taken who shows signs of disease in the heart and vessels, it is obvious that much yet remains

to be done. The percentage of all deaths in civil life, which the circulation deaths show at all ages, is 6¼, between the ages of 15 and 35 it is 6½, between 15 and 45, 8½, whilst between 15 and 25, the ages to which our Army has been tending, it is under 5½. Now as we have already seen the percentage in the Army for three years, 1878–80, was 10·4, and in 1880 alone still 9·1. Again, those diseases are in the Army second in the scale of mortality, whereas they are only sixth in the list of causes of total deaths in civil life at corresponding ages. Although several causes may combine to produce this grave difference, I am convinced that it is the tightness of the clothing which is still hampering the soldier, especially in his more rapid movements. It is much to be desired that the idea of smartness, which is still associated with a degree of tightness and stiffness of dress, should be got rid of, and that our men should be clothed more in accordance with the work they have to do. There is no reason why the clothing should not be made becoming, and we may instance the Navy; no dress gives a more manly and even graceful appearance than that of a sailor, who is equipped for work primarily; besides, the eye would soon accustom itself to a change really useful, and in the words of Vaidy, "La tenue dans laquelle le militaire est pret à marcher à l'ennemi est toujours belle."

Let me now call attention to some of the changes which have taken place in the statistics of the Army in foreign stations, in some of which changes even more startling than those at home have shown themselves. It is of course impossible to do more than glance briefly at a few, and I may select as typical examples the Mediterranean stations, the West Indies, and our Eastern Empire. The redistribution of our Army has greatly diminished the garrisons in many places abroad, but we still retain a considerable number at Malta and Gibraltar, and a large force in India.

Malta and Gibraltar, from their situations and equable climates, ought to be healthy, and in former times they were really healthier than home stations were. Thus in 1837–56 the death-rate at Gibraltar was only 12·9 per 1,000, or one-third less than that of the Army at home; before 1837 it was not very different from that of the Foot Guards in London. Malta was less healthy than Gibraltar in the second period, but not more unhealthy than the average of home stations and less unhealthy than London, as represented by the Guards. In 1860 the deaths at Gibraltar were 12·4 per 1,000, but at that time none of the subsequent improvements had been carried out. In 1861–70, however, the ratio was only 8·54, and the average of the ten years 1870–79 was 6·98. The ratio for 1880 was only 4·24, of which 3·57 only were from disease. In like manner in Malta the deaths have been reduced to one-half of the former rates, but they are still too high, as they are 20 per cent. higher than at home for the ten years 1870–79, and 50 per cent. higher than that for 1880. They also exceed those of Gibraltar by 40 and 135 per cent. respectively. What are the diseases that cause this difference? Chiefly continued—that is, enteric (or typhoid) fever. In other words, the drainage of both places is at fault, but more especially that of Malta. But the sickness at Malta is also too great, being 7 or 8 per cent. above that at home and 20 per cent. above that at Gibraltar. Were it not that a Contagious Diseases Act is in force at Malta, and only imperfectly carried out at Gibraltar, the difference would be more marked still. But it is in the class of fevers that the difference shows itself, the admissions at Malta being 50 per cent. greater than at Gibraltar, and the constantly sick 15 per cent. more. This is due to the existence of a peculiar form of disease, known variously as Malta fever, rock fever, Mediterranean fever, &c., which prevails throughout the Mediterranean shores. It is a painful and protracted disease, as I can vouch for from personal experience, but not a fatal one. It prevails much more at Malta than at Gibraltar, and the cause appears to be defective sewerage. It seems to be a blood poisoning, arising from the soil being more or less saturated with fæcal matter, probably resulting from the practice of cutting drain-channels through the porous rock, instead of laying down impervious pipes. Now the rock at Malta is exceedingly absorbent, whereas that at Gibraltar, being of mountain limestone, is much less so, hence possibly one cause of difference. This defect also tends to the production of ophthalmia; diseases of the eyes are twice as prevalent at Malta as at Gibraltar. All this points to the necessity of remodelling the drainage of Valetta and the adjoining towns and forts.

Turning to the West Indies we find now but small garrisons in the present day compared with those which formerly occupied them; but, such as they are, they present a marvellously improved condition of health upon their state in former times. In 1817–36 the death-rate of white troops in the Windward or Leeward command was 81·5 per 1,000 and in Jamaica 128. In 1837–55 it was 62·5 and 60·8 respectively. In the ten years 1870–79 it was 10·99, and in 1880 only 8·68, or *one-tenth* of the former rate in the Windward and Leeward command, and only *one-fifteenth* of the rate in Jamaica. What were the causes of the former inordinate death-rate and of the great change since? Simply bad hygienic conditions in the one case and their removal in the other, as in all similar cases. In old days the food was bad, the meat nearly always salt, and the use of vegetables was discouraged; the water was generally bad, but rum was only too plentiful. The barracks were totally unventilated, the men slept in hammocks touching each other, there being only 23 inches of width per man allowed, while each had only 22½ square feet of floor-space and 250 cubic feet of total space. And this is the description of the *best* barrack (that at Tobago) in that part of the tropics! No wonder men died at the rate of 10 per cent. in ordinary years and at 25 per cent. in epidemic times. Now all has been changed—food, water, barracks, all have been improved, and we see the result. But there is too much fever and some other diseases, which plainly show that there is still room for improvement.

But our most important possesssion is the great Empire of India, which absorbs one-third of our regular forces even in times of peace. Here we find changes not less remarkable, and of course on a much greater scale. The evidence collected by the Royal Commission

nearly a quarter of a century ago is a mine of information on this important subject. In the first half of this century, in fact down to the Mutiny, the general death-rate of European troops in that country was about 69 per 1,000. In 1812–16 it was 96·5 per 1,000 in Bengal, and in 1819–20, 80 in Bombay. The same causes were found operating, not only dietetic errors and intemperance, not merely heat and malaria, but bad barrack accommodation, a want of proper ventilation, impure water, imperfect removal of excreta, &c. Once these were recognized, steps were taken for their removal, with the usual result —an immediate amelioration of conditions. In 1860–69 the mortality in Bengal was only 31·27, and in 1870–79 only 20·17. In Madras it was 22·5 in 1860–69, and under 19 in the succeeding decade, and in Bombay it went down to 16·37, or considerably under the home rate before the Crimean War. In 1880 the Madras rate was only 10·51, just one-half of the former rate of the Guards in London. This shows to what a low rate the mortality may be brought, and indeed there is no valid reason why this should not be the normal instead of an exceptional rate. As it is, at present we have great fluctuations; thus in Bengal the average of the ten years was little over 20, but the rate for 1879 was 32, whilst that for 1877 was only 12·5, or a difference (taking the latter as unity) of more than 150 per cent. The other Presidencies are not liable to quite such marked fluctuation, but still they are considerable. The causes in Bengal are several, but one of the chief is cholera, which finds its home in the eastern division of it. It is always present there more or less, but every now and then it becomes exacerbated, bursts its usual bounds and spreads into the remoter parts of the province. If we remove the cholera deaths we find that the death-rate is much more uniform and more like that of the rest of India. At the same time the general death-rate is too high, and there is no doubt it can be reduced. There is too much continued fever, that is typhoid, and this is distinctly preventible; there is also too much paroxysmal fever, avoidable by better selection of stations; too much phthisis, avoidable by better barrack accommodation and improved ventilation. The sickness is too large, as well as the death-rate, being twice the rates at home. There is one point that may well be insisted upon, and that is the imprudence of the regulations which confined men to barracks during the most of the day. The motive was good, viz., to keep them out of the sun, but the remedy was worse than the disease, for it compelled them to breathe a foul and tainted atmosphere, which they had again to breathe at night; and it made their lives irksome and monotonous to a degree that was intolerable. Men may be trusted to keep out of the sun without being subjected to such a terrible and destructive ordeal. A proof of what has been said may be found in the fact that those who are least confined to the house in India enjoy the best health. Officers are not so restrained, and their health is better than that of the men; civil servants have to do much of their work in the open air in very hot weather, and they are more healthy still; and planters, who are necessarily active during the day, are the healthiest of all. The Medical Officers on the Madras establishment (as shown by the statistics of the Medical Fund) die at a less rate than those of the British Army, taking all stations together, temperate as well as tropical. In the words of Miss Nightingale, men may live and not die in India; but the condition is that they shall live hygienically, and surely it is the business of the Government that, in the case of troops, who are not free to choose their way of life, no obstacle shall be placed to prevent the best and most hygienic form of life. I feel convinced that if the rules of hygiene were properly carried out, the death-rate in India need differ very little from what it is at home, although men will always be handicapped to some extent by excessive heat and malarious influences. But active lives will combat the former, and improved drainage and means of agriculture the latter, whilst we may hope that it is not chimerical to believe that a time will come when cholera will be merely an historical curiosity. In the meantime it is possible even now to protect the young soldier from typhoid fever, cholera, and dysentery, in which case he is actually better off as regards health when in India than he is in barracks at home.

We may now turn shortly to the question of hygiene in time of war. If hygiene is important in time of peace, it is infinitely more so in time of war. There is nothing which so impairs and ultimately paralyzes a force as disease; no loss that the enemy can inflict in battle being at all comparable to it. This has been recognized by all great commanders. It was preventible disease that caused the collapse at Walcheren, that more than once threatened the armies in the Peninsula, and that produced our disasters in the Crimea. In the Walcheren Campaign there was hardly any fighting; but the position was so badly chosen, without any reference whatsoever to medical opinion, that the fate of the expedition was sealed almost before a shot was fired. In three months 2,000 men perished and 10,000 were attacked with disease, which the majority never afterwards got rid of. One-fourth of the entire force perished (8,000 deaths), and the greater part of the remainder filled the hospitals for many a long day.

The history of the Crimean Campaign is well known. By a combination of circumstances, not unlike that of Walcheren, the first army perished, some 16,000 men dying of disease alone, the most of them during the first winter of the campaign. Unlike the Walcheren story, however, the war lasted long enough to enable a recovery to be made, and we had in the second year a condition of health greatly superior to that of the troops at home, and in the spring of 1856 there was hardly a man who could not have marched against the enemy, the number of sick being in many cases under 1 per cent., and these trifling cases, whilst in some battalions there were practically no sick at all.

The diseases which were most fatal at Walcheren were paroxysmal fevers, typhus (and probably typhoid), and dysentery, aggravated by scurvy. These were the result of malarious site, bad water, bad rations, crowding, and inaction. In the Crimea the diseases were typhus and typhoid fevers, diarrhœa, dysentery, aggravated by scurvy, and at certain times cholera. These were due to the same

causes, except the malarious site, which, however, operated on the army in Bulgaria. My colleague, Professor Aitken, has also drawn attention to the marked influence which previous exposure of troops has in diminishing their power of resistance. In the Walcheren Campaign a large number of men had already gone through exhausting service in the preceding years, and in the Crimean War those men who formed part of the Bulgarian Army suffered to a greater extent than the men who went to the Crimea direct.

Putting on one side the Indian Mutiny, in which the circumstances were peculiar, the next war in which our troops were engaged was that in the north of China in 1860. This was of course a small affair so far as the number of troops was concerned. The total sickness and mortality were at the rates of 2,049 admissions per 1,000, and 53·98 deaths, including both North and South China. In the North China force alone the rates were, from May to July, 1620·7 admissions and 22·55 deaths, and from August to November 15, 1823·8 admissions and 65·54 deaths per 1,000 of strength. Fevers, dysentery, diarrhœa, and cholera constituted two-thirds of the deaths, but if they be compared with the preceding years of Chinese experience it will be found that they differed but little, except for the better, from the previous ratios; for in 1859 the admissions were 2,783·2 per 1,000, and the deaths 59·35, a marked proof of the excellent way in which the hygiene of the Army was attended to.

Our next small war was that of Abyssinia 1867–8. The ratio of admissions was only 891·6, and of deaths 36·14 per 1,000 of strength. There was nobody killed in action, but 9·37 died from accidents, so that the actual deaths from sickness were only 26·77, of which 47 per cent. died from dysentery and diarrhœa, less than 10 per cent. from fever, there being but one death from continued, that is (probably) typhoid fever. This is an excellent example of good hygiene in the field.

In the Ashanti Campaign of 1873 the amount of sickness was small if we consider the nature of the country in which the war was waged. This was due to the facts that a suitable season was selected, that the war was carried out with great skill and rapidity, and that the arrangements for the hygiene of the troops were admirably planned and well carried out. As it was, the sickness amounted to about 1,700 admissions, and the deaths to 31 per 1,000 of strength (per annum). The Officers in this campaign actually suffered more than the men. The chief diseases were fevers, chiefly remittent, sunstroke, and heat apoplexy, and dysentery and diarrhœa; but the comparatively small mortality, in an expedition campaigning in one of the most pestilential countries in the world, is a very remarkable circumstance. Now, in all these three campaigns—in China, Abyssinia, and Ashanti—the influence and advice of the Medical Department were allowed very great weight, and as in each case the principal medical Officer of the expedition was a man of great ability and long experience, the Army profited accordingly.

I now come to the most recent operations. Although the campaigns in Affghanistan and South Africa are both interesting and full of instruction, I should not have time to dwell upon them within the limits of the present lecture. I shall, therefore, refer briefly to the late war in Egypt only. The events of it are fresh in the memory of all, the genius with which it was planned and the consummate skill with which it was carried out. It was waged in the hot season of a sub-tropical region, under circumstances which placed great strain upon every part of the force. Yet the hygienic results are extremely good. Out of a force of 13,013 average strength there were 7,590 admissions to hospital in a period of 87 days, of which 671 were from wounds and injuries, leaving a ratio of admissions for disease of 530·2 per 1,000. If this be expanded into a ratio per annum it becomes 2,222. Of these about 10 per cent. were constitutional and venereal disease, not peculiar to campaigns, so that the total amount may be reckoned at 2,000 per 1,000 per annum; of these only 17 per cent. were febrile diseases, whilst 38 per cent. were diseases of the digestive system, chiefly dysentery and diarrhœa, and nearly 17 per cent. ophthalmia, which is always so common in Egypt. As for the deaths, there were 172 deaths in the whole force, of which 98 were from battle or accident, leaving only 74 from disease, or a ratio of 5·88 per 1,000 for 87 days, equal to 24·67 expanded to a year, a rate not much greater than what the Guards showed in London before the Crimean War. It was even 6 per cent. less than the exceptionally healthy Abyssinian Campaign which had previously stood out as a hygienic model. If to this it be added that, in a country with such an evil reputation for the disease, not one man out of 1,145 cases of ophthalmia lost his sight, and that there was, *for the first time in the history of the world*, a campaign fought without the occurrence of a single case of so-called hospital disease, pyæmia, hospital gangrene, and the like, I think I may well express my opinion that the Army Medical Officers did their duty, and deserved well of their country, in spite of the unjust obloquy which has lately been heaped upon them, but which time will as certainly remove as it has done in similar cases in times gone by.

In conclusion, I wish to call attention to the difficulties which hygiene has to encounter in time of war. Putting aside the necessary exposure to the vicissitudes of climate and weather, the want of food that may occur, or the insufficient character of the rations, and various other *lædentia*, more or less inseparable from a state of war, there is one very serious difficulty, and that is the great compression of population. The most open order of camps in war-time gives a much smaller space per head than the most crowded conditions in civil life, and camps may be so compressed as to give only 8 square yards or less per head. Each person in London has about 96 square yards, in Paris about the half of this, but to give even the Paris allowance would spread an army over a space too great for military purposes. When, in addition to this, drainage has to be extemporised, and the ground covered with latrines, and when pure and wholesome water is a difficulty, it is little wonder that disease breaks out. It is to those circumstances that the typhoid fever, which has characterized our campaigns in South Africa and Egypt, must be attributed in great

measure, as well as in some degree the dysentery. I would suggest under such circumstances, that fire should be brought more into requisition and everything be burnt that is combustible. It is a standing rule in camp to burn all rubbish, but I would suggest that all excreta should be mixed with combustibles, such as straw or saw-dust, if procurable, and burnt. It would even repay the trouble to carry petroleum for this purpose. Similarly, I would, as far as possible, cremate all bodies, which can be done by means of ambulatory furnaces. Could those precautions be carried out, and all water that affords the least suspicion boiled, we should go a long way towards getting rid of some of the most fatal but preventible diseases which attack troops in the field. If cholera or yellow fever invaded a force, I should advise the burning process to be rigidly applied to all stools and vomit, and none but distilled water to be issued to the troops, if it could be managed.

Although we are far from having solved all the questions of hygiene or of the causation of disease, there are sufficient principles established to enable us to say that, if the rules already recognized were strictly carried out, we should be able to cope successfully with preventible disease, even under the difficulties and impediments which are inseparable from active service in the field.

Mr. Edwin Chadwick, C.B.: May I be permitted as an old Sanitary Commissioner to express my very great pleasure at the paper that has just been read, in the extent to which it displays the operation of sanitation in the Army during peace? The progress I think may be marked in this way. Here amongst the Guards, some twenty years ago, the death-rate was 20 per 1,000. The death-rate amongst civilians of adults of the wage class I take is, in or about Westminster, not less than 12 in 1,000. If a man of that class had formerly enlisted in the Guards it would have been at the expense of nearly a double death-rate, but if he enlists now when the death-rate is only 6 in 1,000, or about one-third of what it is in some years, he will gain proportionately in the duration of his life and working ability. I think even including war risks he would be safer than if he remained a civilian. When these conditions are known (which admit of yet further improvements) it should conduce to the abatement of the present very serious difficulty of recruitment. With a completed sanitary service and complete sanitation men of the wage classes, he, instead of having to encounter an insurable large loss of life, may have an insurable small one, with the war risks included. It would add to the interest of the subject if the comparative progress that is making in sanitation in the Armies of France and Germany could be got and stated in detail. But everywhere in civil life, as well as in the Army, the obstacles to sanitary progress are the alleged expense of the the measures to effect it. Now this great principle should be known, that a heavily death-rated civil population, as also a heavily death-rated army, is an expensive population and an expensive army. I have no doubt if you estimate the expense of the present conditions in India, where the money saving has been during the last decade upwards of five millions, it will be found to be an economy upon the expenses. Take an example from civil life. In some of the slums the death-rates are as much as 40 per 1,000 as compared to 15 per 1,000, to which it has been now brought in the model dwellings and in a number of urban districts. The death-rate of 40 per 1,000 will include 25 funerals per annum in excess and beyond that some twenty times that number of sickness, and also of disablement of more than one-fifth of the cases of adults, and a loss of working ability for several weeks. When all these expenses which must be incurred are added up, it is clear that well conducted sanitary operations may be conducted simply for the saving of money; quite apart from the saving of pain and misery, and of premature mortality. What I have said as to the Army is on the progress of sanitation during peace. I should make a large reserve, especially from the last example, as to any great progress made as displayed in the recent war. There is one point I must take a little exception to, and that is, I cannot concur in the results stated with respect to the recent war in Egypt; and I think Dr. de Chaumont has made a mistake which he ought to correct, namely, in spreading the death-rate for eighty days over the whole year. We have at present an Intelligence Department for getting out conditions that will have to be encountered in war. My opinion is we ought to have an Intelligence Department for ascertaining what is the condition of things that will have to be encountered in other countries, and which may cause us three or four times as great a loss as the loss by the sword. If for instance there had been an early sanitary reconnaissance into Egypt, there would have been—several days before the landing, or immediately upon the landing of the force—a knowledge of the unsanitary conditions to be dealt with, and action could have been taken accordingly, and I believe if there had been a good sanitary reconnaissance you would have found that there were camping grounds well known to all the natives, well known to the doctors of the place as being dangerous to encamp upon, while others close by would have been safe. Such an omission may not have been due to any fault of the General; it might have arisen from the hurry of the war. Lord Wolseley has in his excellent manual given very good instructions as to what should be done on those occasions, that he would require from the sanitary officers an examination and a report on the condition of the camping ground, and upon such report he would be governed as to the stations that he continued to occupy. I might illustrate the fatal mistakes committed with the first army in the Crimea, and how they were corrected by the work of the special sanitary commission for the second army, and how, so far as we at present know, the losses that have occurred in the last, fortunately short, campaign, might have been prevented. However that may be, this paper showing the progress that has been made by sanitation during peace, and the yet further progress that may be expected, I deem a good contribution to sanitary science, and I think thanks are due to my colleague of the Sanitary Institute for the pains he has taken, and I only hope that he may have strength and power to continue them for a long time to come.

General R. Maclagan, R.E.: There are one or two points in the paper to which we have listened on which I desire to make a few remarks. Some very important observations have been made on what is known to be a very important matter, the accommodation of our soldiers in barracks. With reference to the amount of cubic space allotted to each man, there are circumstances apparently in which great deviations from the rules on this subject are yet not attended with any hurtful consequence. An advantage seems to be gained when the number of men accommodated within one room is small, though they may not have the amount of floor area and cubic space usually considered necessary. In India, on certain occasions when men have of necessity been accommodated for a time in much smaller buildings than are usually alloted to them, but in which only three or four were in one room, it was remarkable how healthy these men were. In one instance at a station on the frontiers of the Punjaub when an addition had to be made to the number of European troops, and the accommodation was insufficient, a number of the men were for a time put into vaulted apartments under the barracks originally intended for stores. It was meant to be a very temporary arrangement, the rooms being considered quite unsuited for the accommodation of Europeans. However, circumstances required them to be kept there for a considerable length of time, and as a matter of fact, these men so accommodated, were among the most healthy of the European soldiers in that province. It would be a very rash thing to generalize from such a fact, and infer that this was a good mode of accommodating soldiers; all we can say is that there must have been some circumstance there which prevented any evil effect from the reduced space available. One reason, no doubt, was that these apartments were much more protected from the sun by day and from the cold by night. Next, with regard to the lecturer's observations regarding the effect on the health of soldiers in India from being confined within their barracks during the long hot day, while other persons who are not so confined and have much out-of-door duty, enjoy better health,—(civil Officers, military Officers, engineers, and others—

it should be noticed that for the most part these civilians, Officers, and others who have certainly a great amount of out-door occupation have that occupation just as the soldier has, chiefly in the early morning and in the evening. Civil Officers are generally as much within doors during the day as soldiers, and often under much more unfavourable circumstances for many hours together in crowded court rooms; and though the Officers, civil and military, may often have occasion to be much in the open air, even in hot weather, their families are always as much confined to the house as the European soldiers to their barracks. Their better general health is due probably to their having better general accommodation, better food, plenty of air in their houses, and other advantages; but not to their being less confined to the house than soldiers. On the subject of the amount of cubic space, I think the lecturer observed that 3,600 cubic feet per man was just equivalent to one cubic foot per second. This seems to imply that the whole of the air is renewed in the course of an hour. That I think can scarcely be assumed. There was one very interesting part of the lecture on the connection of work of various kinds with the health of the troops; and notice was taken of the comparative healthiness of cavalry, artillery, and infantry. It would have been of great interest if the comparison had included the engineer soldiers, the sappers and miners, who are generally so much more employed than most of the other men on out-door work. When infantry soldiers have been employed on public works, as they have frequently been in India on hill roads, their health has been particularly good. The employment has been no less advantageous than the hill climate. May I be allowed, with reference to the remarks of the last speaker, to supplement what I said just now on this subject? There is no question that the occupation of the mind of the soldier, besides being profitable in itself, is one of the most important aids to bodily health. In India, a great deal has been done of late years towards providing this in an advantageous way. The men do not now usually occupy the same rooms during the day and during the night. The newer barracks are double-storeyed. In the lower storeys are the recreation rooms and mess rooms, and rooms in which they carry on various occupations during the day. The upper storeys are the sleeping rooms. In trying times of sickness also, the occupation of the mind is most important. On the occasion of a sudden outbreak of cholera among our troops in India, it is found best to move the men at once out into camp or temporary shelter, even at a season when they would never, under ordinary circumstances, be put under canvas, and the immediate occupation of the mind in making the move, the roughing it, the inconvenience serves perhaps as much as the mere change of place and air to fend off the attack of that terrible disease. We have reason to be glad that this subject has been brought before us so fully as it has in the lecture to-day. It is a subject not second in importance to any of those discussed within these walls, affecting so directly and closely as it does the efficiency of our Army.

Major-General Dunne: Following the Officer who has just spoken with regard to the troops in India and their being kept all day long in their barrack rooms, I may mention that at places like Fort William, in Calcutta, it would be absolutely impossible to allow young troops any freedom comparatively, of going about in the day in hot weather. My own experience of India as a young man was that a great deal of the sickness amongst infantry when they are first put into barracks in India, arose from the fact that they had a large amount of meat and used to drink a large quantity of beer, and that they had nothing in the world from morning to night to amuse their minds. They had no occupation from breakfast time in the morning until 5 or 6 o'clock in the evening. I have no doubt the Officer who last addressed us will corroborate this, that the infantry soldier did nothing but eat a big dinner and then tuck himself under his mosquito curtains and snooze away half the afternoon. I think if more indoor recreation could be found for the men, great improvement would result. No doubt, of late years there has been more occupation found for them. But I think they should not be allowed to go about in the open in the heat of the day. Soldiers could not be trusted—they would have sunstroke over and over again; but to amuse them and give them occupation in barracks is the best thing for them. No doubt why the Engineers are a more healthy body of men in India than the infantry is for the simple reason that their minds are more occupied and there is more work for them to do during the day.

Colonel BAYLIS, Q.C.: I venture, not being myself one of the regular army, to make a few observations, but with considerable diffidence. Most useful practical suggestions have been made, and they are founded upon the best of statistics. Are these useful measures of prevention to go on? We trust that this lecture will not be without its fruits. We are sorry to see so few attending a lecture of such general importance not only to the Army but to every one. I can only account for it in this way: if you talk of measures of prevention to persons, they are always somehow or other loth to follow them; it is only when something overtakes them with great severity that they will attempt to do anything in the future to prevent its recurrence. And I am not clear but this is the cause of it: it is found that the more successful measures of prevention are somehow or other the less do they appear to be needed, and the less are they followed up by further reform. People do not look at results sufficiently; they say the world is working very well, but they do not look sufficiently at the cause of its working. Now we all allow that a great deal of the present improved sanitary state of the Army is due to precautions which have been taken; and we only hope that the effect of this lecture will be to follow up what has been done and to let these practical suggestions be carried out. The lecturer attributes a great deal of mischief to the tight dress worn in the Army. We know that with ladies appearance goes a very great way, and so it seems to do in military matters. I hope, however, that some practical result will come from this lecture, and that it will be seen that the first consideration is to make the Army healthy and thereby effective. We must all also admit that the occupation of the mind has a great deal to do with the health of the body. I hope, therefore, we shall look after the *mental* occupation of the Army. If whilst doing that, we give the men as much opportunity as possible for following active and healthy pursuits, physical and mental, we shall find less disease and they will not have recourse to those things which so often bring on disease. The suggestions as to the selection of camp sites, and taking precautions beforehand, I think are most important, and I venture to hope they will be carried out.

Dr. DE CHAUMONT: I should wish to say a few words in reply to some of the remarks that have been made. In the first place with regard to what has fallen from my friend Mr. Chadwick on the subject of the statistics of the Egyptian campaign, he must allow me to correct him, for he has not quite apprehended what I have stated. I stated that the total number of deaths from disease during the period of 87 days was 74 out of a total force of 13,000. Now if that is taken as a ratio for that 87 days alone it gives a ratio of 5·88 per 1,000. But if I expand that ratio to a whole year, that would come to 320 deaths, which upon the 13,000 gives the ratio which I gave of 24·67 per 1,000, and I do not think it would be possible to make it any more. I expanded it for a whole year by multiplying the deaths in the ratio of 365 divided by 87, and that gives 24·67 per 1,000, which I think is an extremely small ratio for a campaign fought under such very adverse circumstances. With regard to the remarks by General Maclagan and also Major-General Dunne, I quite agree that a great deal must be laid to the occupation of the mind of the soldier, and there are no doubt many causes of unhealthiness other than mere confinement to barracks, but speaking of the time of my own experience in India, which I am sorry to say is nearly a quarter of a century ago, there is no doubt at that time men were confined to barracks the whole day and the air was extremely foul, and I think I was able to trace the bad effects of it in the general health of the men. Of course if the men are sent to another room to pass the day it is a good thing, but the main objection I was bringing forward was that the men were confined to barracks in an improperly ventilated air space, which they were again compelled to occupy during the night, and I still maintain at that time the remedy was worse than the disease. The men would not have suffered so much if they had been allowed the utmost freedom in the open air. Of course if it is found that men cannot be trusted to protect themselves from the sun there is no doubt precautions must be taken to protect them, but it must be done in an intelligent way,—in such a way as shall be an advantage to the soldier and not a disadvantage. There one remark that General Maclagan made with regard to the

amount of fresh air which I suggest as being necessary. He said that this would demand that the whole air of the barrack should be changed every hour. But we not only demand that, we demand three times that. Even in the present day the limited demand of the Barrack Commission is that the air shall be changed in every room at least twice in the hour in order to give a man 1,200 cubic feet. He gets 600 cubic feet of space, and if he ought to have 1,200 cubic feet of air the air must be changed twice in the hour, but we say the air *may* be changed three times in the hour. I think it is quite possible we may get increased space and 3,600 cubic feet per hour for the soldier by-and-bye. And this brings me to another point that was referred to also by General Maclagan, namely that the case has occurred more than once where men have been placed under apparently adverse circumstances, as for instance where they have not been allotted the full amount of cubic space, and yet have maintained very good health. I do not deny that at all; I think it is quite likely, but other circumstances must come in, and I would here point out what is very often forgotten, or not understood, that cubic space itself is no substitute for ventilation, that is to say what we want is that men should have fresh air delivered to them; it must be delivered in such a way as will be without injury to them in the way of chilling them, or being otherwise unpleasant, but they must have a certain amount of fresh air, and it is perfectly immaterial how it is given, but under no circumstances can cubic space ever be permitted to take the place of fresh air. Many men think if you put the men in a large room, that is all that is required, but if you occupy the room for a few hours shut up, it will be poisoned just as much with 10,000 cubic feet as if it were 100. If it is impossible to deliver a sufficient amount of fresh air and a man occupies only 600 feet of space, it is obvious you must give him more, but this is merely with reference to the practicability of a continuous delivery of air. A man may keep his health perfectly if he is only occupying 100 ~~square~~ cubic feet of space if he could be provided with a sufficient number of cubic feet per hour, or he might attach a respiratory apparatus to his mouth and nostrils, and in the foulest atmosphere you might keep him alive and healthy by bringing fresh air to him and taking away the foul air. The cubic space is quite a side issue with regard to the actual ventilation, so that in these cases where men have been apparently crowded together, in all likelihood the fact has been that there were large openings through which fresh air could very easily be brought in. Men are very often crowded together in the open air, and if the crowding is not too excessive they may keep their health. I might have added, as has been suggested, the statistics of other armies, but it would have rather prolonged the lecture. I may merely mention that the experience of our own Army is by no means unique, and that if we study the results obtained in the French, German, and Austrian Armies, we find that the same conditions produce the same evils, and the same remedies have produced similar results. The death-rate in the French Army has been reduced at least one-half both in France and in the Colonial service. In Germany and Austria the same thing has occurred; with improved measures of sanitation, especially improving ventilation and sewer arrangements, they have got rid of a very large amount of disease, but there still remains the instructive fact that in the foreign Armies there exists a very large amount of preventible disease that we are gradually getting rid of. For instance, typhoid fever is only too common among the French soldiers. Anyone who has experience of the abominable way in which the excreta or sewage is dealt with in France will easily understand why this should be, and why such diseases as typhoid, diphtheria, &c., should rage in foreign cities when they are a very small item in the death-rate here. I will just remark with regard to this, the difference between what we do in this country and what is done abroad. My friend, Dr. Vallin, Professor of Hygiène at the Val de Grâce, told me the conclusion he had come to was this: "Your streets" he said, "in your cities, particularly London, are filthy, dirty, and your sewers are simply abominable, but your houses are admirably clean, and you have a copious supply of water, and therefore you are healthy. In Paris," he said, "our streets are beautifully clean, you might have a dinner party in the sewers; but we keep all the filth in our houses and the water supply is totally insufficient: the result is we are decimated with disease. After all," he says, "your system is the best" and I think we may say so too.

The CHAIRMAN: I cannot pass over the discussion which has taken place in this able paper of Dr. de Chaumont's, without adverting to a subject with which, however, he does not deal at all, and that is camping. Mr. Chadwick has stated that there is great fault to be found with camping ground in Egypt. I need hardly tell my audience here that an army in the field cannot always choose its camping ground; it must camp where its General wants it. I must say, however, from what I have heard both here and elsewhere regarding the selection of the camping ground at Cairo, that the only camping grounds that could have been occupied were those which were occupied, and that the authorities who determined to camp the troops in the place where they were encamped at Cairo had the very best information on the subject, namely the advice of the Khedive of Egypt and his staff. I feel it necessary to say this in justice to the advisers of the General and to the General who commanded the Army in Egypt than whom I fancy there is no more competent sanitary or strategic General perhaps in our Army. I think it right also to say that the Army was well advised by a very competent sanitary Officer who was on the staff of the Quartermaster-General in Egypt. With regard to the paper, I have one single remark to make, and that is that the whole of this admirable narrative, based as it is on statistics which do not admit of being disputed, shows if anything can show clearly and very logically too, that we are certainly on the right road to secure for our Army the best possible health consistent with the conditions under which soldiers must serve, and, therefore, I hope that the result of this admirable lecture, containing as it does information on the subject given to us in previous years by the same author, will be that the Government will be stimulated to continue those sanitary efforts which have done so much for the health of the Army, and for the saving of life in the Army, and that thus the ranks of the Army will become more and more popular and its efficiency more and more marked. With these very brief observations I would ask you to give our distinguished lecturer a very warm vote of thanks. Although our audience here is a limited one yet it is a very influential one, and when it is borne in mind that this lecture through the medium through which it will be published will address itself to almost every Officer in the British or Indian Armies, I have no doubt that you will think that the hour devoted to the consideration of this subject this afternoon has been extremely well spent.

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F. de Chaumont.

MILITARY HYGIENE.

A LECTURE DELIVERED AT THE ROYAL UNITED SERVICE INSTITUTION.

(Authors alone are responsible for the contents of their respective memoirs.)

(*For private circulation only.*)

LECTURE.

Friday, May 27th, 1870.

Sir T. GALBRAITH LOGAN, K.C.B., M.D, Director-General Army Medical Department, in the Chair.

MILITARY HYGIENE.

By F. de Chaumont, Esq., M.D., Army Medical School, Netley.

The subject which I have the honour to bring to your notice this day is one of so comprehensive a character, that I might well hesitate before attempting its exposition in a single lecture. I hope, however, to be able to lay before you a few points of interest selected from the wide range of inquiry which the study of hygiene embraces. Let me say a few words in the first place as to the nature and character of the study. Hygiene (or *medical police* as it used to be called in this country) is that branch of study which treats of the laws of health. This is its widest application, and we hesitate to call it a science, chiefly because it is based upon many other divisions of knowledge which are themselves still imperfect; it is, in fact, as yet merely an art by which we apply to the preservation of health the points of knowledge derived from many sources. Its highest aim being to produce the "mens sana in corpore sano," it is obvious that nothing which bears directly or indirectly upon health is excluded from it, which is simply tantamount to saying that it includes everything cognisable by man. But, the causes that act and react upon the human economy being practically infinite, to integrate them so as to produce a definite expression which shall be presented as a perfect science is hopeless. All we can hope to do is to approach as nearly as possible to the limit which can never by any possibility be reached. But within this vast circle there are others to which we may profitably confine our attention for the time, and within which we may direct our inquiries to those points in the material well-being of man, which are more immediately under our control. Hygiene, then, is the art of preserving health by removing all that is injurious to life, and supplying all that is needful for life. It aims at rendering life vigorous, painless, free from disease and prolonged, so that a truly hygienic being would cease to exist purely from natural decay. Whether or not it would be possible to lengthen life materially or indefinitely, is a speculation which has often suggested itself, but which we are at present too ignorant to consider.

Hygiene, although but recently placed on a scientific basis, is by no means a new object of human study; it is at least as old as history itself. The ceremonial law of Moses was as perfect a system as the knowledge of the time could produce. Hippocrates embodied in his works the

precepts of many older and now forgotten writers. The life of the Greeks was eminently hygienic. The vast systems of baths built by the Romans, their system of sewers, their mode of water supply and many of their domestic arrangements, proved how far they understood the art of health in peace, while the rules of Vegetius may be even now profitably studied as a guide in time of war. It was reserved for the fanatical asceticism of the middle ages to outrage every law of health, to impose upon the world the idea of the contemptibility of caring for the body, and in fact to accomplish what may be fitly termed the apotheosis of filth! What can we think of a community in which the cleanliness of the body was regarded as a pollution of the soul and the cynosure of all devout eyes was such a hideous mass of filthy insanity as St. Simeon Stylites! The outcome of all this was, that epidemics of a virulence unknown to classic times devastated Europe, and it was only with the revival of letters, when the intellect of Europe began to shake off the shackles of tradition and priestly domination, that a return was made to the paths that had been so long forsaken. Even now with all our boasted science, we are only going back in a measure to the principles already firmly established fifteen centuries ago, but the practice of which disappeared with the fall of the Western Empire. We are even now in some practical points behind that age, and it will be long before we make up for the death-like sleep of a thousand years, during which, as Michelet says, not one in Europe ever took a bath!

Hygiene in its detailed application includes the following points:—the supply of *air*, *water*, *food*, *clothing*, *shelter* and *exercise*, and the removal of *waste* and *effete* products arising from what source soever. Deficiency in the supply of the above requisites weakens the human frame and induces constitutional diseases; neglect in the removal of waste products favours the development of actual poisons which give rise to epidemic and zymotic diseases. This is of course a general statement requiring modification according to individual circumstances. The relative importance of each cause advances, both as regards rapidity and intensity of effect. Thus, whenever a sudden invasion of disease takes place, affecting a large proportion of a community at the same time, such as an attack of diarrhœa, it is generally due to some poison introduced through the water-supply, and it is seldom that inquiry fails to trace it to this source. On the other hand, the most fruitful source of disease, although less immediately recognisable in its operation, is impure air from defective ventilation. While to bad water we owe in a large measure the propagation of such diseases as diarrhœa, dysentery, cholera, typhoid fever and the like; to bad air we owe pulmonary consumption, pneumonia, typhus fever, scrofulous disorders, and many others, some apparently *generated* by the products of respiration, others unquestionably *favoured* and propagated by a want of proper interchange of air. The importance of this question with reference to the health of the soldier is so great that I propose to ask your attention for a little to the subject. The necessity for good ventilation and the proper methods of obtaining it have been very fully discussed of late years, and it may be considered as pretty generally admitted that it is a question of the very gravest moment. Death-rate has been shown to increase in a pretty regular ratio with the increase of inhabitants to the square mile, and, putting exceptional causes aside, the most virulent disease and the greatest mortality are to be found in the most crowded localities. Of course among the civil population, poverty and starvation have to be taken into consideration, for among them crowding necessarily means poverty, want of means compelling them to huddle together to save the crushing expenses of house-rent and fuel. Among soldiers, however, it is possible to eliminate these disturbing causes to a certain extent, for the men are selected lives, are, on the whole, well fed and clothed, and are not more exposed in time of peace to vicissitudes of temperature than the civil population. Yet, in spite of these advantages, and putting aside all other deleterious influences, the researches of the Royal Commission of 1857 showed that the death-rate of the soldier at home was up to that time *twice* that of the civil population of the same ages. To what was the death-rate chiefly owing? To two diseases mainly, viz., typhoid fever and pulmonary consumption (or a destructive lung-disease). Now the former is almost entirely due to bad conservancy, that is, neglect in the removal of excreta, and the latter by far the more destructive, to bad air, caused by bad barrack accommodation and deficiency of the supply of fresh air. The whole question was carefully investigated by the Commissioners, and the conclusion arrived at was, that to *bad air* the greater part of the Army mortality in time of peace was due. This was a conclusion for which the public generally was hardly prepared, but its truth was borne out by other investigations, for the same results arising from similar conditions were found to obtain in Continental Armies as well as in our own. Nay, further than this, similar influences were also found producing analogous effects among the lower animals, horses in badly ventilated stables, dogs in confined kennels, and even monkeys in ill-constructed dwellings were found to fall rapid victims to destructive lung disease, having in many cases characters similar to that which carries off so many of our soldiers. Since that time a very great change has taken place, increased accommodation and better means of ventilation having been provided in accordance with the recommendations of the Barrack Commission assembled in the following year, 1858. Imperfectly as these recommendations have been as yet carried out, the results are most encouraging, for the death-rate of the soldier now is reduced to *one-half* of what it was before the Crimean War, a most cheering and gratifying fact, even if we admit that it is not entirely due to this one set of changes. For although numerous causes have undoubtedly combined to bring about this result, yet enough of it may be traced to direct hygienic improvements to encourage us to make every effort to promote further advances in this direction.

I have alluded to the recommendations of the Barrack Commission as having been imperfectly carried out; let me now explain what I mean. The recommendations were that each soldier should have 600 cubic feet of space in barracks, and 1,200 in hospitals, and that the air of this space should be changed *twice* in the hour, thus giving

1,200 cubic feet per head per hour, in barracks, and 2,400 in hospitals. To accomplish this, improved methods of ventilation were recommended and in some cases supplied. I have now made detailed experimental inquiries in a good many barracks and hospitals, and I take this opportunity of laying before you very briefly the results, which may be seen by a glance at the accompanying table. From it you will observe that the rate of change of air is considerably below *twice* in the hour in the majority of instances, so that to provide even the moderate amount of air proposed by the Barrack Commissioners, a much larger initial cubic space would be requisite, or in other words the number of occupants ought to be reduced:—

Place. / Barracks.	No. of times air changed per hour.	Cubic space required per man to give the proposed amount of air, viz., 1,200 in barracks, and 2,400 in hospitals.	Average actual amount supplied, taking the initial space at 600 per man.
(a) Netley .... (one room)	3·30	365	1980
Hilsea......... (brick huts)	3.25	370	1950
Fort Brockhurst	3·00	400	1800
Aldershot...... (ventilated on principles of Barrack Commission)	2·35	520	1410
Chelsea........ (no outlet shaft)	2·20	550	1320
....	....	....	....
Hilsea......... (room over stable)	1·74	690	1044
(a) Chatham	1·70	710	1020
(a) Netley.........	1·65	730	990
Fort Elson..... (no shaft)	1·30	925	780
Gosport	1·20	1000	720
Tower.........	1·20	1000	720
Anglesey	1·20	1000	720
(a) Milton Barracks, Gravesend	1·18	1010	708
Aldershott..... (original rooms in permanent barracks)	1·16	1020	696
(a) Chatham.......	0·80	1500	480
(a) Netley.........	0·72	1670	432

Hospitals.	No. of times air changed per hour.	Cubic space required to give the proposed amount of air, viz., 2,400 feet per hour.	Average actual amount supplied taking the initial space at 1,200 cubic feet.
Hilsea........	3·12	770	3744
Herbert .... (Woolwich)	2·20	1095	2640
Portsmouth*... (Garrison Hospital)	1·10	2180	1320*
(a) Chatham ...... (Fort Pitt)	0·90	2660	1080
(a) Netley.........	0·90	2660	1080
(a) Chatham ...... (Fort Pitt)	0·55	4350	660
(a) Netley.........	0·55	4350	660

From these numbers we see that the results contemplated by the Commission have been obtained in only *five* barracks and *two* hospitals, viz., those above the dotted lines in each table. The experiments from which the calculations have been made were carried out by myself, except in those cases marked (*a*).

I think it will be admitted, on considering these results, that a good deal still remains to be done, even to arrive at the moderate degree of ventilation proposed by the Commission. I am, however, far from admitting that even this would be sufficient to ensure perfectly hygienic conditions, but it would still be a great advance upon the actual state of things. It cannot be too frequently insisted upon, that there is a practical limit to the number of times that air can be changed *without draughts* by ordinary appliances, and that therefore there is a limit to the number of occupants in an air space, which cannot be exceeded without serious danger to health, and even life. Theoretically speaking, the cubic space a man occupies is immaterial, *provided* always that the power of changing the air is unlimited; but it is perfectly plain that, if we cannot change the air more than twice in the hour, four men in that air space will only get each one-half as much as two. Therefore in placing a limit to the cubic space allotted, the possibility of changing the air sufficiently often, ought to be one main element of the calculation. The whole question is one of expenditure, for of course increased cubic space means more extended barrack accommodation, and greater outlay, both for warming and other things. On the other hand, special appliances for ventilation are also costly, and few have as yet given much satisfaction. I do not doubt, however, that we shall arrive ultimately at some means of combining economy with efficiency in this

* In this case the initial cubic space was only 800 feet, so that the air supplied was only 895 cubic feet per hour. Had the wards been full the space would have been only 680, and the amount of air 748 cubic feet only.

matter, and securing to the soldier an habitation which shall be really a shelter, and not a manufactory of disease.

I have dwelt thus particularly upon the question of ventilation as being the most important with regard to the soldier's health in time of peace; it is the most fruitful source of mortality, and the most constantly operating cause of disease. Of course it is not actually of less importance in time of war, but it is relatively less so on account of the presence of so many other causes which unite to attack the health of the soldier. I propose now in the remainder of this lecture to refer to some of the more important of these.

In the first place the actual amount of physical exertion to be gone through is generally greater in time of war. Can we do anything in time of peace to prepare the soldier for this? For we must never forget that the trade of the soldier is war, and that, but for the existence or the possibility of war, he would cease to have a *raison d'être*. Many soldiers pass through their whole career without ever encountering actual warfare, but their whole training is to render them fit for a possible contingency, which, it is true, may never arise, but which the soldier must ever be prepared for. The amount of physical exertion which a man can undergo depends upon many things, the way he is fed, the way he is clothed, the climate he is in, and innumerable other causes which influence his health, morally and physically. Our first care, then, should be to preserve his health at the highest standard in time of peace by supplying an ample and wholesome diet, appropriate clothing, well ventilated barracks, &c. But there still remains the question of training and exercise. How far should these be carried in peace, with a view to the severer trials of war? It is the opinion of some that the amount of physical labour in peace should be strained to the utmost, even beyond what is likely to be required in war, so that when the latter comes it may be found more easy of endurance. It was on something like this principle that the Romans acted, giving their men so much labour in peace time, that they hailed the approach of war with delight, as a season of rest and variety. This was, perhaps, good policy in a nation eminently aggressive, who loved war better than peace, and claimed to make it an object of attraction to its citizens. But the condition of matters is changed at the present day; we keep an army as a necessity, but a necessity which we regret. We do not desire to instil a longing for war into our citizens; we merely wish to keep the instrument of defence in the highest state of efficiency, ready to be used on the instant when the hour of war does come. Under such circumstances it seems to me that it would be an eminent mistake to train the physique of the soldier too far; full and constant occupation he ought to have, but considerably within the limits of extreme physical effort. It stands to reason that a cord perpetually stretched will lose its elasticity, and probably give way when the important moment arrives. I think this is now pretty generally understood, and it receives an instructive illustration from the practice of professional singers, who by exercising their voices within a moderate compass, find that they can the more easily make an extreme effort when the occasion calls for one.

It is not, however, only in the preparation in time of peace that the power for physical effort depends. Man is a machine, just as much as a steam-engine or a galvanic battery; the amount of force he gives out is exactly proportioned to the amount of convertible material he takes in. We can calculate to a grain the force obtainable from the burning of a certain amount of coal, or the oxidising of a certain amount of zinc, and similarly (though, as yet, somewhat less perfectly) we can calculate the amount of force obtainable from the amount and quality of food supplied to the human economy. And this question of food is at the bottom of all the difficulties and disasters of a campaign. It used, in the great war in the beginning of this century, to be a favourite joke of the French soldiers against the English to say that you should never ask an Englishman if he has *fought* well, but ask if he has *dined* well, and then you may be sure he has fought well. Like many a word spoken in jest, there is deep truth contained in this, of whatever nationality the soldier may be. There can be no doubt that armies have performed prodigies of valour under circumstances of great privation, but we may be sure of this, that as Providence has been said to be on the side of the largest battalions, so it will also be on the side of the best fed battalions. This is well put in the report of an experienced French Officer, Colonel Comte de Clonard, commanding the 81st regiment of the Line. He says: "Devant l'ennemi, "il suffit de payer un instant de sa personne; l'exemple des chefs "entraîne, électrise: le drapeau fait le reste. Hors de là, c'est autre "chose, car on ne se bat pas toujours. Dans les marches et les camps, "au milieu de fatigues et d'épreuves souvent nécessaires et glorieuses, "c'est par une bonne ou une mauvaise administration qu'on préparo "les hommes à vaincre ou qu'on les perd. Il faut donc savoir faire "*durer* le soldat, mais c'est à la condition d'en avoir soin, de lui donner "une alimentation suffisamment réparatrice et parfois *tonique* et *variée*; "il sera dès lors en état de braver impunément toutes les autres "misères de la guerre." (Chenu, Campagne d'Italie.) Nothing, indeed, lays a man more open to an attack of disease than encountering it insufficiently nourished. On this principle medical men and the attendants on the sick, never, as a rule, visit a contagious case on an empty stomach, if it is possible to prevent it. Now, in providing for the diet of the soldier in war, two important points have to be borne in mind:—

1st. To provide a diet that shall furnish sufficient force for the work required of him; that is, to make the food proportionate to the exercise.

2nd. To provide a diet of sufficient variety to prevent the occurrence of scurvy.

The importance of the first point has been more or less recognized at different times, and it would appear that Hippocrates (the great father of medicine) had very clear notions on this point. It was, however, possible to come to a definite conclusion on the subject only after the sciences of chemistry and natural philosophy had been brought to a high stage of advancement, and after the theory of the conservation of force had been recognized. So long as heat, light,

electricity, chemical action, vital force, &c., &c., were considered separate entities, it was hardly possible to treat the question scientifically, but now that all these are admitted to be mere forms of force, or, perhaps more correctly, to be universally and perpetually convertible into each other, equivalent for equivalent, we are enabled to approach the inquiry with more confidence, and to place our conclusions on a more strictly scientific basis. The question is still obscure, but researches are gradually throwing more and more light upon it. After Liebig had pointed out the two important divisions into which food may be separated, the nitrogenous or plastic, and the carboniferous or combustible, the idea long held almost undisputed sway that the former went to repair the tissues whose waste supplied muscular energy, and that the latter were burned off in the lungs and supplied the necessary animal heat. It was therefore supposed that a certain amount of nitrogenous matter and a certain amount of carboniferous matter being given, life could be sustained in efficiency. Further inquiry showed that these views were only partially true, for it was found that all nitrogenous substances were not equally assimilable, some, notably gelatine, although largely present in the bodies of animals, not being capable of being substituted for albumen or fibrin, and not being nutritious at all except under peculiar circumstances. It was also ascertained that the carboniferous aliments required subdivision into two classes, the fats and the carbo-hydrates (the latter including the starches and sugars) which two classes could reciprocally replace each other in certain proportions, but not entirely. A certain amount of mineral matter in the form of salts, either existing in the articles of diet or added in bulk, was also found to be absolutely essential for the preservation of health. Up to this point, the results ascertained were the following:—

1. Living animals absolutely require nitrogenous matter in their diet.
2. The nitrogenous matter may be animal or vegetable.
3. Most animals require a certain amount of fat.
4. Many animals require, in addition, a certain amount of starch or sugar.
5. All animals require a certain amount of salts.

A second series of conclusions are the following:—

1. Some animals (such as dogs and rats) can live on a purely meat diet.
2. Many animals (carnivora) can live upon meat and fat.
3. Many animals (herbivora) live upon vegetable products only (including nitrogenous matter and starch chiefly, with a small quantity of fat.)

4*a*. *Man* can live on vegetable products only, provided they contain nitrogenous matters, starch, and fat in due proportion.

b. *Man* cannot live and maintain health upon meat alone, or upon meat and fat alone; he requires the addition of starch.

These being the main conclusions, how were they interpreted? It was considered that the carbo-hydrates—starch and sugar—were chiefly employed in giving out the animal heat; that the fat acted partly in this way, and partly was stored up in the system against contingencies; that the nitrogenous went to repair the wasted tissue, chiefly the muscles, and that it was the wasting of these that supplied the physical force manifested by the individual. These principles are still defended by Baron von Liebig, Lyon Playfair, and other distinguished men; but, on the other hand, a large number of experiments have been made by men of great scientific acquirements, such as Pettenkofer and Voit, Fick and Wislicenus, Lawes and Gilbert, Haughton, Parkes, and others, which seem to point the other way. If the waste of the muscles were the direct or sole cause of force, then, in cases of excessive exertion, some increased elimination of nitrogenous matter would be observable; but the majority of the experiments seem to show that this is not the case, so much so, that in some cases the elimination seems to be lessened, apparently from the increased exercise causing retention of the nitrogen to provide for the increase in size of the muscles, which usually follows. On the other hand, increased exertion is attended with increased elimination of carbonic acid and vapour of water, showing a marked excess in the combustion of the carboniferous matter in the system. The inference suggested by these observations is, that the body is, in the main, like a steam-engine, and that the force evolved is due to the combustion of the fuel supplied. Therefore, it is to the carboniferous elements of food that the energy is in the main due, and not entirely, as was supposed, to the nitrogenous. The body, however, differs materially from an ordinary machine, for the latter wears away without power of reparation, all we can do being to diminish as much as possible the effects of friction. The former, however, has the power of perpetually assimilating fresh material, and continually repairing the waste as it occurs. It is obvious, however, that in the latter case *some* force must be evolved, just as there is force (in the form of heat chiefly) evolved in the friction of the wheels of a machine, and it is important, therefore, to inquire what becomes of this force, how it is employed, or how it is neutralized. It would seem probable that it is partly employed in the digestion and assimilation of the nitrogenous matters, and partly in the elimination of the waste products. Now, as the balance seems to be kept pretty strictly between the amount of nitrogen ingested and egested in a person well fed and in good health, it is probable that the amount of nitrogenous food necessary for the highest efficiency is that which shall preserve this balance most perfectly under varying circumstances. If the amount of nitrogen be diminished below the proper standard, weakening is produced, with emaciation, the result of more rapid destruction than can be repaired by the fresh material supplied. But if at the same time the amount of physical exertion is proportionately diminished, this lessening of the nitrogen is balanced to a certain extent, and can be endured within certain limits, whilst a comparatively small quantity is required for actual subsistence in a state of complete rest. If, however, exercise be continued, then, as it appears that the muscles while in action appropriate nitrogen, this nitrogen must either be supplied by the food, or be drawn from some other part of the body. In short, in the absence of a proper supply of food, the active muscles feed upon those parts which are less actively employed, or which are less capable of resisting the depredation. In this way, the heart is apt to suffer; it is itself in constant action, and therefore requires a large supply of nitrogen, which supply is diminished if the voluntary muscles are thrown severely into play without sufficient provision being made by increased food. It is thus evident that an increase of nitrogen is necessary in direct proportion to the increase of work; but the energy necessary for the work is certainly not wholly, nor even mainly, derived from the nitrogenous matter. It is quite true that the body is able to use nitrogenous matter in this way, but generally this is on compulsion, as it were, and when no other material has been supplied; but the loss of force under these circumstances is so great that the system soon becomes exhausted. It is, therefore, necessary to supply material which is easily oxidised, and capable of rapidly yielding up its potential energy under the influence of the changes wrought upon it in the lungs and circulation. This material is supplied in the fat and carbo-hydrates of which I have already spoken. Weight for weight, the fat has about $2\frac{1}{2}$ times the potential energy of the carbo-hydrates, but it is doubtful if it could be used alone in their stead. In the Arctic regions it appears to be capable of being used in this way to a very great extent; but in temperate and tropical climates it does not appear capable of entirely replacing starch. A practical proof of this was given me by an Officer who served in the Cape, and who told me that on one occasion he formed one of a party of men who for three weeks had nothing but mutton (with, of course, the usual amount of fat) and water. They managed to march on this diet, but their strength gradually gave way, and at the end of the time they were barely able to stand. On the other hand, it is doubtful whether a diet composed of fat-free meat, starch, and water, could support life in a state of efficient health. I am not aware of any satisfactory experiments on this point. One difficulty attending such experiments would be that there are few natural starches which are not mixed with other constituents. All the cereals, for instance, contain both nitrogenous and fatty matters. Potatoes and rice probably contain least fat of the natural starchy matters generally obtainable. It would seem, then, on the whole, that we cannot completely replace either starch or fat, and that a considerable quantity of these substances is necessary for health. Further, as the greatest part of the energy necessary for work is due to them, they must be materially increased whenever more work is demanded.

There still remains another class of substances which are essential to health, this is the *salts*, including the sodium chloride chiefly, the potassium chloride, calcium and magnesium phosphates, &c. All these, except the first, are taken entirely in the food, which requires to be sufficiently rich in them to be thoroughly nutritious. The sodium chloride is also present largely in the food, but the requirements of the body necessitate in addition a considerable quantity to be taken in bulk,—and it may be a question whether some of the others might not also be taken in the same way with advantage. The use of the salts, apart from those such as the calcium and magnesium phosphates which enter into the composition of the tissues, is rather obscure, but one use can be pretty clearly shown, viz., that they materially assist in the oxidation of matters, whether effete or otherwise, and therefore play an important part in the animal economy. Wherever, then, increased energy is demanded, calling for, of course, increased oxidation, a considerable increase of salts must accompany the additional food. Part of this will of course be supplied in the food itself, whilst part must be added in bulk, chiefly the sodium chloride, but perhaps also some of the others, as the potassium chloride, &c.

The point now to be considered is: How much food ought to be supplied? To answer this we must refer to some of the recent experiments which have been made to calculate out the potential energy obtainable from different kinds of food. This is generally stated as so many foot-tons, that is, as equal to so many tons raised through one foot. There are various ways of expressing it, but we may adopt this one as being very generally used and easily understood. It being possible then to calculate how much energy is obtainable from each substance, what we require to know, in order to apportion diet to exercise, is the amount of force required. Now, we can calculate pretty correctly the amount of work done by an individual, and we can also (from Professor Haughton's ingenious researches) ascertain the force expended by the involuntary work of the body, such as the heart's action, &c.,—but there still remains a quantity more difficult to estimate, viz., that required for the evolution of the animal heat and other processes in the system. We can, however, arrive at this experimentally by finding the amount of food which will keep a man alive at rest, considering this as the minimum, and also the amount which will keep him in health at average work. To this latter we can then add proportionately for excessive work. The subsistence diet for a man at rest, calculated from Frankland's figures (Parkes's Hygiene, p. 170), is the following:—

Nitrogen........	138	grains	Equal in potential
Carbon	3,030	,,	energy to about
Salts	219	,,	2,330 foot-tons.

Now, as the work of the heart, &c., has been calculated at about 260 foot-tons, there would remain 2,070 as absolutely required for the animal heat and other processes at the lowest calculation. But this must be materially increased with every increase of exertion, for the heart works more rapidly, the circulation moves quicker, the chemical changes go on at a greater rate, and more animal heat is wasted. Accordingly we find that the standard average diet for a man at work is as follows:—

Nitrogen......	316·5	grains	Equal to about 3,833
Carbon	4862·0	,,	foot-tons of poten-
Salts	461·0	,,	tial energy.

If now we consider that a man on this diet is doing a good day's work,

equal to 300 foot-tons, and add to this 260 for the internal mechanical work, we have remaining for the animal heat, &c., 3,273, or an increase over the subsistence-diet of 1,200. It would therefore seem as if for every foot-ton of external work, we ought to add in addition about four more for the internal processes, or we must supply five times the potential energy as food that we expect to obtain as labour. Even this calculation, however, is short of the mark, for we find that the amount increases at a greater rate as the work advances. For a man doing laborious work, that is, equal to about 450 tons per diem, the following is the mean calculated diet:—

Nitrogen........	450	grains	Equal in potential
Carbon	6,242	,,	energy to about
Salts	580	,,	4,784 foot-tons.

Or an increase of 1,049 potential tons to provide for the additional 150 tons of productive labour; here the increase is seven times instead of five,—so that the addition required as work increases is almost in a geometrical instead of an arithmetical ratio. Let us now examine the diets issued to soldiers, and compare them with the above standards. The ordinary diet of the English soldier at home is the following (as calculated by Dr. Parkes):—

Nitrogen........	266	grains	Equal in potential
Carbon	4,718	,,	energy to about
Salts	354	,,	3,640 foot-tons.

In this diet the carbon is about sufficient, but the nitrogen is much too small, and the salts are also deficient in quantity. It is right to mention that Dr. Playfair has calculated out the diet as rather more nutritious, bringing up the energy to 3848·5 tons. I cannot help thinking, however, that there has been some difference in the mode of estimate, and that Dr. Playfair has calculated the ration of meat as *without* bone, whereas it is really reckoned including bone. Adopting, then, Dr. Parkes's calculation, we find that the above diet is much below the average of a working-man's standard, and that it is a diet in short on which we could not demand more than a very moderate day's work, say 150 to 200 tons. It is true that in time of peace the soldier's duties are not so arduous as those of the majority of labourers, but still the above diet is insufficient to keep him as he ought to be kept, in the highest state of health. Were the meat ration to be increased, as was at one time proposed, from 12 to 16 ozs., including bone, the diet would then stand thus—

Nitrogen........	303	grains	Equal in potential
Carbon	4,918	,,	energy to about
Salts	379	,,	3,838 foot-tons.

The salts would still be rather low, but the diet on the whole would be a fair one, sufficient for average work of from 250 to 300 tons—not by any means an excessive estimate, seeing that a march of ten miles in heavy marching order is alone equal to 250 tons. When, however, troops come into the field much more is demanded of them, and the diet ought to be arranged accordingly. We have to bear in mind that not only is there more actual work, more waste of tissue, bodily and mental, but that also the food is in many cases not so good in quality, and, therefore, incapable of yielding the same amount of potential energy. A war-diet ought to provide for a minimum work of 350 to 400 tons, and be capable of being increased at the shortest notice to 500 tons or more, as circumstances call for it. Such a state of things would be met by a diet of the following proportions :—

Nitrogen........	350 grains	Equal in potential energy to about 4,280 foot-tons.
Carbon	5,500 ,,	
Salts	450 ,,	

To be increased as circumstances demanded to—

Nitrogen........	450 grains	Equal in potential energy to about 5,000 foot-tons.
Carbon	6,500 ,,	
Salts	500 ,,	

Now, in scarcely any instance has a war-ration reached this amount. In the Crimea in our own Army the ration *nominally* came to about 272 to 290 grs. of nitrogen, about 4,400 to 5,000 of carbon, and about 280 to 320 of salts; but it was only late in the campaign that this ration was really issued. It will be but too well remembered by those who passed through the first year of that memorable war, how miserably deficient the ration really was. Our own errors and misfortunes at that time have, however, been fully criticised and exposed, and I should fear to weary you unnecessarily by going over the same ground again. But it is only comparatively recently that a full account of the experiences of our allies has been published in the two great works of Dr. Chenu, viz., the Reports on the Crimean and Italian Wars, the latter work containing in an appendix many documents referring to the former campaign. From this we find that the ration in February, 1856, consisted of the following:—

Bread..	.. 750 grammes	= 26·50 ounces	Total 41·04 ounces.
Meat..	.. 300 ,,	= 10·60 ,,	
Rice ..	.. 60 ,,	= 2·12 ,,	
Sugar	.. 20 ,,	= ·70 ,,	
Coffee	.. 16 ,,	= ·56 ,,	
Salt ..	.. 16 ,,	= ·56 ,,	

Fresh meat was distributed four times in ten days, salt meat (250 grammes = 8·8 ounces) on three days, and preserved meat on three days. If biscuit was issued, 550 grammes (= 19·4 ounces) were given. An *occasional* extra ration was issued, according to circumstances, of—

Biscuit ..	100 grammes	= 3·6 ounces.	
Wine ..	$\frac{1}{4}$ litre	= 8·8 ,,	three times a week.
Brandy ..	$\frac{1}{16}$,,	= 2·2 ,,	four times a week.

This was equivalent to the following :—

Nitrogen..	.. 263 grains	Equal in potential energy to about 3,348 foot-tons.
Carbon ..	.. 4327 ,,	
Salts ..	.. 472 ,,	

The additional ration when issued would add about 78 grains of nitrogen, 660 of carbon, and 26·6 of salts, and of potential energy about 400 tons. It is obvious from what has gone before that such a diet was totally inadequate to support men on active service. It is true that additional rations might be issued "à titre de remboursement," but the pay of the French soldier is very small, and he could hardly have added much to his diet in that way. Besides this, I am afraid that even this insufficient diet existed chiefly on paper, for from the information I could myself gather in conversing with French Officers, it would seem that fresh meat was not as a rule distributed anything like so often as four times in ten days. The insufficiency of this diet was fully recognized and protested against by the Medical Officers, whose remonstrances were, unfortunately, too often disregarded.

In the rations of the Prussian, Austrian, and Russian Armies, the same error seems to prevail as in the French and English, viz., a deficiency of nitrogen and a too great preponderance of starchy matters, a diet, in short, insufficient to preserve men in health during active work.

I have gone in some detail into the *quantity* of food, let me now say a few words as to the *quality* and *kind* of food required. If it be necessary to supply a sufficient amount of food to yield energy adequate for the work required, it is not less essential that the food should be properly proportioned and sufficiently varied. An apparently sufficient amount of energy would be obtained by *calculation* from a diet consisting of pure starch and pure albumen, but such a diet would be practically useless, for it could not long sustain life. There are four essential divisions into which the food requires to be separated, viz., albuminates or nitrogenous substances, fats, starchy or saccharine substances, and salts, and these ought to be in something of the following ratio :—

Albuminates	10
Fats	6
Starches (or carbo-hydrates).. ..	30
Salts	2

These are taken in their proportions when thoroughly dried, all the water being completely driven off. Now in the soldier's diet generally there are the following fundamental errors :—

The albuminates are *deficient*.
The fats are *very deficient*.
The starches are *somewhat in excess*.
The salts are *rather deficient*.

Another important error (now somewhat rectified) is the great sameness of the diet. Monotony of diet soon causes the food to pall, the appetite is diminished, and the health suffers. The great enemy that armies have to contend with is scurvy; but for the scorbutic taint it would be comparatively easy to deal with the other causes of disease. Even cholera would lose half its terrors in presence of a thoroughly well-fed body of men. We are still very much in the dark as to what the nature of scurvy is, but we know a good deal empirically of the ways in which it is induced; the following have been ascertained:—

Scurvy may be induced	*May be cured by the use of*
By deficiency of fresh vegetables. ,, of nitrogenous food. Probably also by deficiency of fat. By mere sameness of diet.	Fresh vegetables, lime-juice, vinegar, salts of vegetable acids, increased nitrogenous food, variety of diet.

The effects of want of vegetables, and the beneficial results from the use of lime-juice, are well known. With regard to the effects of deficient nitrogenous food, various cases are on record, one of the most striking being that of the Perth Penitentiary, as recorded by Professor Christison. Scurvy there came on in consequence of a ration of molasses being substituted for milk from motives of economy. On the milk being restored, the scurvy rapidly disappeared. It is true that here there were salts also concerned, for milk contains them in large quantities. Still I think it may safely be said that scurvy is likely to follow any material or prolonged disturbance of the equilibrium, which ought to be maintained between the different articles composing a diet, and that even with this equilibrium kept up, mere sameness of diet will after a time induce it. Once it is set up in a body of men, the most disastrous consequences follow—dysentery, diarrhœa, typhus, rheumatism, ulcers, &c., are sure to break out, and it besides leaves the system totally unfitted to resist any epidemic poison that may present itself upon the scene, so that cholera and typhoid fever find easy victims. To see the truth of these remarks we have only to look at the history of many campaigns. Scurvy seems to be everywhere, accompanied or closely followed by dysentery and typhus. We shall not be surprised when we bear in mind that the two main causes of these diseases are bad and insufficient diet and crowding, two causes which have almost always been but too generally present in wars. If there is more or less starvation without crowding, fever will always follow, but it is a fever of the relapsing type, and of itself rarely fatal; it, however, weakens the system extremely, and lays it open to attacks of other diseases. But if to starvation we add crowding, then typhus is inevitable.

Now, it is almost impossible, from the nature of things, to avoid crowding in war, as an army must necessarily occupy a smaller proportionate space than the most crowded city. In the Report of the Royal Commission of 1857, some calculations are given on this point. In East London, the most densely populated part of the kingdom, the number of persons per square mile is 175,816. To provide even the amount of space which this represents, we should have to give

ON SCURVY IN THE MERCANTILE MARINE.

ON SCURVY IN THE MERCANTILE MARINE.*

By WALTER DICKSON, M.D., R.N., Medical Inspector of Customs.

[*Read June 4th*, 1866.]

THE subject of scurvy in the merchant navy has of late excited a considerable amount of attention. It is surprising that, in the present state of our knowledge, a disease so easy of prevention and cure should exist at all. But that it should especially infest the ships of a country like England, placed in the foremost rank of maritime nations, is a lamentable fact unworthy of an age which boasts, and not without reason, of its enlightenment, philanthropy, and material progress.

I purpose in these observations to give some account of a series of investigations which I have been called on to make during the last two years by direction of the Board of Trade, with the view of ascertaining the origin of the disease in various ships which have arrived in the port of London, and in which cases of scurvy were either so flagrant or so numerous as to demand the notice of the Government.

The medical officer of the Privy Council had, in his Annual Report for 1863, given sea-scurvy a conspicuous place among preventable diseases requiring further State interference. At his request, Dr. Barnes, one of the physicians of the *Dreadnought* hospital ship, produced a valuable report, so complete and exhaustive, as to leave little to be desired. The records of that noble and truly catholic charity abounded with illustrations of the disorder in every degree of intensity, and there is probably no existing institution where it can be studied to such advantage. Dr. Budd, during his tenure of office as physician, had contributed the fruits of his experience in an elaborate and still standard treatise which was published about thirty years ago in the *Library of Medicine*. Indeed, it is to the medical officers and managers of the *Dreadnought* that the authori-

* Much of this paper has since appeared, under another form, in the "Lancet" of January, February, and March, 1867.

ties and the public are indebted for having the subject forced on their attention. Dr. S. Ward has contributed some most instructive clinical lectures on scurvy and other maladies incidental to seamen; and the present resident medical officer, Mr. Leach, has distinguished himself by his assiduous and zealous endeavours to expose existing abuses and to obtain justice for the helpless and friendless class of men who come under his care.

The most unsatisfactory feature in the recent history of scurvy is, that notwithstanding acknowledged improvements in the condition of seamen, the disease appears to have increased during the last fifteen years rather than diminished. The number of cases received on board the *Dreadnought* in that period has varied from 50 to 150 in the year, the mean number of admissions annually being about 90; and, as a rule, more numerous in the latter than in the earlier years of the period. The average proportion of scurvy to all other diseases and accidents received into the hospital has been 1 to 24, or 42 per 1000. Even in last quarter the cases admitted were 39, a large number as compared with corresponding quarters of 3 years, viz. 22, 20, and 15. At the other great sea-ports, the ratio has been equally high. At Liverpool, for example, in six years, 228 cases were received into the Southern Hospital. Taking other hospitals of that town into account, not less than 50 cases are annually treated at Liverpool. And in all these, it must be remembered, the scorbutic symptoms are of considerable intensity. The minor forms of the disease mostly escape professional notice, but they are notoriously very prevalent. At the Poplar Sailors' Home, according to Mr. Corner, one-half of the inmates are affected in some degree, and one-twentieth are seriously afflicted.

If we now turn to the scurvy-stricken ships, we shall find the proportion of sick among their crews to be often very large. In a list of 26 vessels given by Dr. Barnes the ratio is stated as ranging from 9 per cent. to 90 per cent. on the strength. The crews of these ships averaged 20 in number, and the mean proportion of cases of scurvy they yielded was 4, being at the rate of 20 per cent. In the vessels inspected by me the proportion of cases has been very similar, and, as in the others, chiefly occurred in ships from Liverpool, Sunderland, Glasgow, etc. It would seem, therefore, that our north country ports have an unenviable pre-eminence in this particular. The voyages most productive of scurvy are those from India and China, as might be expected from their length; for the disease seldom breaks out in less than 60 days, and the duration of the passage from the eastern ports varies, for the most part, from 90 to 150 days. Any gross defect in the diet of the crew will therefore show itself in an unequivocal manner in the last days or weeks of the homeward voyage.

The cause of scurvy is so well known, that it is unnecessary to discuss it. In whatever degree certain conditions of the individual, and certain kinds of aliment, may predispose to and hasten its manifestation, the disease is, in all cases, directly owing to the absence from the food for some time of fresh vegetable matter. The remedy is of the most obvious and simple kind, and, except in extreme or complicated cases, is invariably effectual. But (rare thing in our art), the preventive treatment is equally simple, easy of application, and infallible. In the systematic use of a wholesome and very agreeable beverage we have an undoubted specific, the efficacy of which has been amply tested in every sea and in every variety of climate. It is singular that this happy expedient of lime-juice, which in the last eighty years has saved so many thousand lives, and has helped, in no small degree, to build up our country's greatness, should have had to struggle into notice very slowly, and with much opposition. Woodall, a surgeon of London, in the year 1636, described its powers in terms as graphic as they are quaint:—

"I find we have many good things that heal the scurvy well on land, but the sea chirurgeon shall do little good at sea with them, neither will they endure. But the use of the juyce of lemmons is a precious medicine and well tried; being sound and good, let it have the chief place, for it will deserve it. It is to be taken each morning, two or three spoonfuls, and fast after it two hours; and if you add one spoonful of aqua vitæ thereto, to a cold stomach it is the better. Some chirurgeons also give of this juyce daily to the men in health, as a preservative, which course is good if they have store, otherwise it were best to keep it for need. I dare not write how good a sauce it is at meat lest the chief of the ship waste it in the great cabins to save vinegar."—*Surgeon's Mate or Military and Domestic Medicine.*

Woodall's knowledge of lemon-juice was probably derived from an older time, yet it was more than a hundred years after his day before its antiscorbutic qualities were fully recognised, and it was enlisted as a most valuable ally in our greatest naval war.

It is still more singular that although employed with unfailing advantage for the best part of a century in the royal and higher class mercantile marine, lemon-juice should still be unappreciated and rejected in so many quarters, and that even where it is used, its utility should so often be marred through ignorance and prejudice in regard to the details of its preservation and mode of issue. And yet these details are of so simple and obvious a character that it would seem almost a waste of time to dwell upon them. But we find in every day experience that it is from a want of knowledge of these apparently insignificant minutiæ rather than from any wilful neglect or perversity of judgment, that an invaluable remedy has in some measure lost its reputation, and has even come to be doubted by those who are most interested in using it.

Some captains will attribute the disease to cold, as it most often makes its appearance when the vessel gets into the more northern latitudes, and when there is a considerable and rapid fall of temperature; some will ascribe it to debility or constitutional peculiarity of the individuals attacked; others will look on it as, in almost all cases, the manifestation of a syphilitic taint, while a few entertain the idea that when it once appears it is propagated by contagion —a weak person has at first been affected, and from him it has been communicated to the rest. Yet these officers are, in general, shrewd and intelligent men, and, although the tie betwixt them and their crews is of a comparatively slight and temporary kind, I believe that, with few exceptions, from motives both of expediency and humanity, they have the material well-being of the seamen at heart. Among the men there appears to be an equal divergence of opinion. Bad provisions, bad water, are most often alleged as conducing to it, and sometimes bad treatment. Unless the question is put directly to them, both officers and men agree in ignoring the real cause of the malady, viz., the absence of really good and efficient lime-juice, or irregularity and neglect either in issuing or consuming it. It may be broadly stated that in almost every case of the manifestation of scurvy the lemon-juice was proved to have been either originally spurious or to have become deteriorated by the faulty mode in which it was preserved; to have been issued carelessly or irregularly, or to have been systematically declined by those who should have drunk it. It not unfrequently happens that, from exposure to the air in a tropical climate, lime-juice has undergone decomposition, and become positively loathsome, and that the men are therefore quite justified in refusing a draught which, besides being nauseous, is altogether useless.

There is also a so-called lime-juice, pleasant to the taste, and so closely resembling the genuine article both in chemical composition and flavour, as to be by the uninitiated almost undistinguishable. It is prepared artificially from citric acid, and is preferred by many captains as being much less liable to spoil than the true expressed juice of the fruit. Although extensively used, I believe this compound to be greatly deficient in curative or prophylactic virtues, if indeed it possess them in any degree whatever. To this plausible sophistication even more than to grosser adulterations may be chiefly attributed the ill repute into which lime-juice has of late most undeservedly fallen. I have found, in several instances, that the use of this artificial lime-juice did not prevent the outbreak of scurvy in a highly aggravated and even fatal form. There is reason to believe that reliance on it, and all similar compounds, is entirely misplaced, and that misconception on this point, and the erroneous practice thereby engendered, have been a fertile source of scorbutic disease. Indeed, it seems highly probable that this well-meant, but futile, endeavour to improve on the unimprovable has been an efficient factor in causing the very remarkable increase of scurvy in recent years.

In London and all the greater ports, lime juice can be obtained in abundance at a reasonable price, and of perfectly satisfactory quality. There seems to be no doubt that the great majority of ships are supplied with a genuine article. But by a curious perversity of custom this perishable commodity, of such essential importance, is not treated with the care that would be bestowed on beer or wine, or other liquid of vegetable origin. In most of the vessels I have visited it has been stowed in bulk in a cask of considerable size (from fifteen to twenty gallons) supposed to last the whole voyage of ten or twelve months, without any spirit being added for its preservation, and opened at intervals of a week or two to allow of a quantity to be drawn off for use. Exposed in this manner to the air, crossing the equator four times, and agitated by the incessant motion of the ship, it is not surprising that it should lose most of its original properties. In truth, it is singular it should preserve any of them, and should not invariably undergo a change to the repulsive-looking liquid which in my inspections I have sometimes seen, and of which I now show you some specimens. But with due precaution lime-juice may be kept for

periods far exceeding the length of any modern commercial voyage with unimpaired efficacy. Although placed otherwise in most unfavourable circumstances, the second North Polar expedition, under Parry, did not suffer until they had been dependent on their ship resources for more than twenty-seven months, and in the latter expedition, under M'Clure, Dr. Armstrong informs us that a similar period elapsed without any sign of scurvy. So much was I impressed with this prime defect in many merchant ships, that at the very outset of these investigations I insisted strongly on an alteration in the mode of packing lime-juice.

The Board of Trade in some degree acted on this recommendation by causing a large number of copies of my report to be printed and sent to all the local marine boards at the various ports for general circulation. Time will show whether the advice has been generally followed. Some traders now supply it in one or two gallon jars, but even this, although a great improvement, is in my opinion too large a quantity for the purposes of a small crew; for it must be remembered that, in a voyage to India or China and back, the whole consumption will not exceed the rate of about one gallon per man, and that in the class of ship in which scurvy is found most to prevail, the daily consumption does not exceed half-a-pint for all hands.

Before the lime-juice is bottled it is essential to ascertain its quality. By an experienced person good lime-juice is easily recognised by the simple tests of taste, smell, and specific gravity; in cases of doubt a chemical analysis would be desirable. The specific gravity of true natural juice is always higher than the imitations. Mr. Leach has paid much attention to this subject. The results of ten good specimens gave a density ranging from 1030 to 1040, and showed a dark residue on being evaporated to dryness. The specimens of reprehensible quality showed a specific gravity from 1021 to 1026, and yielded hardly any residue; allowance must of course be made for spirit should it be added before the hydrometer is used. The proportion of mucilage and other organic matter in lime-juice is considerable. In a recent analysis made by Mr. Witt for Dr. Bence Jones, one ounce was found to contain less than two grains of inorganic matter (accurately 1·728 grains). Three-fourths of this small amount consisted of potash, in combination with sulphuric and carbonic acids; the remaining quarter of a grain was composed of phosphoric acid with soda and lime, and traces of silica, iron, and magnesia; the rest is made up of water and citric acid, of which there are forty grains in a fluid ounce.

Several years ago Dr. Garrod ascribed great importance to the presence of potash in lime-juice and other anti-scorbutics. He announced that the disease depended on a deficiency of potash in the blood; that the diets which cause scurvy contain less than the proportion of potash necessary to health, and that the administration of potash alone was sufficient either to cure or prevent the disease. Nitrate of potash has been reputed by some a good anti-scorbutic, but the experience of the Royal Navy, and especially of Dr. Bryson and others in charge of convict ships, has led to the conclusion that it is comparatively useless or inert, if not injurious. From the remarks of Dr. Barnes, also, the value of this salt seems to be extremely doubtful, and he quotes a remarkable instance of scurvy having broken out to a great extent among a party of lumberers in Canada who were fed on pork salted freely with nitre, and to this circumstance, indeed, Dr. Grant, who described the cases, mainly ascribed the outbreak in question.

I perceive that the Dreadnought Society, in their preventive recommendations, suggest, in the absence of lime-juice, that five grains of the bicarbonate of potash should be given twice a day.

It appears to be at least doubtful whether the anti-scorbutic property of lime-juice is due to the presence singly, either of the large proportion of citric acid, or of the infinitesimal quantity of potash contained in it. May it not rather be the combination of both with the *organic* constituents, in a manner so subtle as to elude our present chemical knowledge, which is essential to its prophylactic power? We know that *that* power is fleeting, and must, in a longer or shorter time, disappear; yet the potash, on which so much stress has been laid, is one of the least perishable of its constituents.

The regular and sufficient issue of lime-juice to the crew is of paramount consequence, yet in most merchant ships it is the exception rather than the rule. It should be left less to the discretion of the men themselves, but should become an integral part of the discipline of the ship. I consider it more judicious to serve out lemon-juice in small quantities daily, than in larger quantity once or twice a week. The crew should be taught to regard it as essential a part of their daily food as meat or biscuit. Allowing for the long oceanic voyages ships now make without touching for refreshment, I would recommend that, in the latter part of the voyage, the issue should be increased to one ounce per man, with an equal quantity of sugar or molasses, and a pint of water. The mixture should be made before dinner and served out to the crew under the superintendence of an officer, so that it should be drunk at their meal; some who now neglect it might thus be induced to take it with regularity, and even enjoy it. Sea-faring men are capricious, and in some minds there is a prejudice against it. In some ships of war I have seen this met by mixing the allowances of grog and lemon-juice together—a mild form of compulsion which was found to be effectual. At present the Act requires the juice to be issued when a vessel has been ten days at sea; this period might in most instances be shortened with advantage. I would recommend it be given simultaneously with the salt provisions without any delay, and even with fresh meat when, as sometimes happens, no green or succulent vegetables accompany it. For many years, and in very different parts of the world, I have been able to carry this practice into effect, and with success, not only in obviating scurvy, but also in warding off other maladies from which, through want of a salutary variety of diet, sea-faring persons are prone to suffer; such are dyspepsia, diarrhœa, and dysentery; ulcers, night blindness, and idiopathic debility, all of which there is reason to believe partake of the scorbutic type in some degree, although the more prominent and characteristic symptoms of scurvy are absent.

A wholesome and varied food, with a due proportion of fresh vegetable matter, should always be procurable in harbour, and with a little pains and foresight at sea also. No single article of diet can be persisted in for a long time. It is well established that with a purely fresh meat diet scurvy may occur, and indeed must occur, if vegetables are altogether withheld. The history of military operations, both ancient and modern, are full of illustrations. Salt provisions are negatively injurious, from their monotony and from their inferior power of nutrition, yet seamen are proverbially fond of them, and even when on shore continue to prefer salt and dried fish, ham, bacon, cheese, and the like.

As the time between their voyages is very short (frequently not exceeding a few days), they rarely have the opportunity of enjoying a mixed natural diet for a sufficiently long time to counteract the ill effects of their usual regimen; there is, therefore, the greater need not only of giving a more liberal supply of lime-juice, but of satisfying their wants with preserved meats and vegetables, in as varied succession as practicable, and in taking care that in port, and for some time after leaving port, they have free access to such green vegetables and fruits as the country produces. Some of these, as potatoes, yams, bananas, oranges and limes, will keep for some time. Great carelessness, or rather I should say culpable apathy and indifference, exists on this point to a degree that is hardly credible. Notwithstanding the high perfection to which the art of preserving various kinds of meat and all sorts of vegetables has attained, and their comparatively cheap rate of production, they hardly ever find a place in a ship's dietary. The aliment provided by agreement for the seamen of our day is in no respect different (except perhaps in quality) from that which his forefathers had a century ago. Salt beef and salt pork, flour, peas and biscuit, are still the only description of food which, in the vast majority of ships, is tolerated or enjoined by relentless and unreasoning custom. It is true the quality of these articles is for the most part faultless; quite equal in the vessels I have inspected to those furnished to Her Majesty's ships; yet it seems worse than an oversight that such welcome and inexpensive luxuries as preserved potatoes and other common vegetables, pickles, condiments, and dried fruits, should be habitually denied to merchant seamen. The emigrant and the convict are cared for by legislative enactment, and the man-of-war's-man, besides being more frequently in port, and having sufficient means to purchase for himself, is placed under a parental despotism whose duty and pride it is to protect, at whatever cost, his health and vigour.

Instances frequently occur in the merchant service of vessels lying in tropical ports for weeks without any regular issue of vegetables, and that even while fresh meat is withheld. The idea of procuring a supply for all hands of fish or fruit is never entertained even when these constitute the cheap and natural fare of the inhabitants of the place. Unimproved by their sojourn in harbour, they again put to sea on their return voyage; the lime-juice, as usually packed, is deteriorated; the beef, also, often begins to spoil; the other provisions continue to be good. The vessel has rounded the Cape of Good Hope before even the weaker men are smitten with scurvy; some have had climatic diseases in India or China, and been shipped perhaps from an hospital; some have been suffering from venereal affections, contracted in our vile sea-ports, when they first began their voyage;

others are young and not inured to hardship, with frames feeble and undeveloped. Of such material are the first subjects of attack. The symptoms are obscure, general malaise and muscular debility, with so little apparent derangement of the health or alteration of aspect as to give rise to the suspicion of malingering. But even if unmistakeable signs of scurvy have been revealed, it too often happens that the vessel sights and runs past the Islands of St. Helena and Ascension without stopping. In this age of eager competition, such is the desire for quick passages and corresponding profit, that a ship master does not scruple to encounter the storms of the Bay of Biscay, and the intricate navigation of the channel with half his crew disabled by disease, and so he braves loss of life and cargo rather than brook the delay of a few hours and the expenditure of a few pounds, or it may be shillings, in procuring needful refreshments at those islands.

In corroboration of the well-known fact, authenticated in several of these inspections, that scurvy generally manifests itself in India ships about the time of doubling the Cape, I am informed through Mr. Leach that the admissions of very severe cases in the last five years into the St. Helena hospital, amount to no fewer than about thirty per annum, to say nothing of many more treated as out-patients, in whom the scorbutic symptoms were comparatively milder. The cases admitted were of such intensity that their average duration was thirty-five days, and they formed one-twelfth to one-fifteenth of the whole number of admissions into that institution.

Much stress has been laid, and no doubt justly, on the circumstance that the disease is unknown among the officers of the merchant navy; I have found in my experience some instances to the contrary. In that class of vessel, in which scurvy is most frequently met, and which seldom carry passengers, the ordinary daily fare of the officers differs but little, if at all, from that of the men. They probably take care to secure a few pickles and preserves, besides laying in some fresh fruit and vegetables before leaving harbour. But their immunity, I apprehend, is mainly owing to the habitual, although moderate use of stimulants, more especially in the fermented form, sometimes light wine, but chiefly bitter beer and porter.

The value of these as antiscorbutics was perfectly well known in the last century. Both wine and beer were at one time issued in the navy when practicable, as a regular ration, and the medical officers of that time, who were keen and accurate observers, and were in truth the very founders of hygienic science, furnish ample evidence of their efficacy. The superiority in health of the great fleets which France sent forth in those days was often to be traced to their never having abandoned the use of fresh bread and of wine.

Lime-juice has practically superseded all other beverages for purely medicinal purposes, but it is a question how far a partial return to the occasional issue of beer or wine might not be advantageous. In very few merchant ships are spirits now allowed; tea and coffee are given, but they are too often of indifferent quality, and badly prepared. A wholesome weak alcoholic drink would hardly fail to be acceptable, and there is reason to believe would be beneficial to health.

I have seen in the Royal Navy good effects from the permitted purchase, under proper restrictions, of small quantities of bottled bitter beer. In operations of war in blockading an enemy's coast, our supplies of fresh provisions from the shore were sometimes cut off for long periods, and a slight indulgence of this sort was most welcome to our seamen. In the United States' Navy there was, and probably is, a practice of selling to the men at fixed and moderate prices a variety of little luxuries which, at choice, they might add to the standard dietary of the service. I think the practice by no means unreasonable, and some modification of it might be introduced with advantage into our merchant ships; even in the Royal Navy there is still, I believe, room for improvement in variety of food. Some years ago rations of preserved fresh meat were given twice or thrice a week, but through bad faith on the part of the contractors and other mismanagement the scheme failed. Much of the meat was no better than carrion, the seamen were disgusted, and, as some gentleman present may remember, public indignation was strongly roused. There seems no reason why the experiment should not in more favourable circumstances succeed. The preserved food furnished for our sick is of first-rate excellence, and is most liberally supplied at the discretion of the medical officers.

As anti-scorbutic articles of diet, the preserved vegetables would rank even higher than fish or meats. In the South Polar Expedition of 1844-45, of which I had medical charge, they were issued to the crew with great advantage, so also were pickles, and the dried American apples and peaches, on which the United States whalers set such store

in their prolonged and adventurous voyagings. Treacle is an anti-scorbutic of considerable value; it is much used by our transatlantic brethren, and very judiciously, in cooking pork. Mustard should be, as in the Royal Navy, a constant article of ships' diet. Vinegar, although an agreeable condiment, has no marked anti-scorbutic virtue; it, however, holds a prominent place in the Merchant Seamen's Act. It is ordered to be issued at the rate of half a pint per week for each individual. Vinegar and lime-juice form the only articles of diet secured by law to the merchant marine; all other articles of provision are simply a matter of agreement and private contract. I have had the opportunity of examining the printed articles of agreement of various sizes and classes of ships, but in the kind and quality of food there is little or no difference. Good water is indispensable to health; its direct bearing on scurvy, however, is not very marked. The Seamen's Hospital Society in their printed recommendations remark, that water obtained from a condensing apparatus is much inferior to fresh water, and chiefly from its deficiency in certain salts. I am here inclined to differ. No water can, in my opinion, be purer or in every way more wholesome than that properly distilled, provided it be exposed for a short time to the air and kept in perfectly clean iron tanks. It was only at the last meeting of this Society that I adduced some striking facts as to the value of condensed water as compared with the water of tidal rivers. I mentioned the singular exemption from cholera of ships which used distilled water when that disease was prevailing around them, and the circumstance that even while the disease had been imported from the shore it was not propagated or extended. But this is a digression. I can only repeat that, even if the anti-scorbutic properties of distilled water be feebler (and this to me appears doubtful), such loss is amply compensated for by its being far less likely to affect the bowels than the water generally procured by ships from the great rivers of India and China, even when, as is usual, that water has undergone some process of filtration.

Personal cleanliness is, I conceive, of considerable importance as a partial antidote to scurvy. Merchant seamen are sometimes inconceivably dirty, apathetic and indolent; they thereby sooner fall victims to this disease, more especially when, in their return voyage from the tropics, they come suddenly into the low temperature of our northern winter. Their vital energies are depressed to an alarming or even fatal degree. Cases of this kind have come under my notice in the inspection of vessels which arrived in London in the last two winters.

In cold weather warm water should be allowed for washing. The crew should also be encouraged in exercise, games, or other amusements to beguile the time, as well as counteract the torpor induced by a tedious voyage, and what is to them an excessive degree of cold. The clothing of the men is often insufficient for the vicissitudes of climate which they have to undergo in rounding the Capes Horn and Good Hope, or in arriving in the European seas. Many of those who have embarked as new members of the crew at tropical ports, are utterly destitute of suitable warm clothing; there is no doubt that this defect gives freer access to the inroad and aggravation of scorbutic disease. Overcrowding and bad ventilation would no doubt be a powerful predisposing agent in the causation of scurvy, as has been amply proved by many examples in convict and emigrant and troop ships, and, to go back to an older time, in the Royal Navy. In few of the merchant ships of which I have had cognizance is any fault to be found on this score. The wretched old top-gallant forecastles, where those not on watch used to be huddled together like the lower animals, are now superseded in most instances that have come before me, by spacious deck-houses well lighted and well aired, and yielding better accommodation to their occupants than is to be found in many of Her Majesty's ships.*

The subject of discipline is foreign to our discussions in this Society, yet it is by no means irrelevant to the present question. I may be permitted to observe that considerable allowance must be made for the difficult position of the officers of the Merchant Navy. The crews of the lower class ships are now composed of the most heterogeneous materials, including foreigners of every nation; they are often turbulent and intractable, and the reins by which they are held to duty are slack. The efforts of commanders to maintain order are not always successful; their treatment of the men is sometimes capricious, if not harsh, and occasionally degenerates into heartless indifference. With regard to the discrimination of disease, they must experience much difficulty, when, as in all smaller vessels, they are left to their own resources.

* Some vessels which I have recently inspected for the Board of Trade had exceedingly defective accommodation between decks for the crew. They were chiefly in the West Indian and fruit trade and no scorbutic cases occurred in them.

It is obvious that with a medical officer there is little likelihood of cases of scurvy being overlooked, even when by some ill chance they should have been permitted to occur. But several instances have come to my knowledge where the master has been treating men for rheumatism, or secondary syphilis, or climatic cachexy, and has been astonished to learn that when admitted to the *Dreadnought* they were indubitably suffering from sea scurvy. It may even happen that, with the best intentions he may, by mercurial or other injudicious, hap-hazard treatment, have done them grievous injury. The disease is slowly progressive, and the diagnosis is often difficult to an unprofessional person. Hæmorrhages, and even the spongy gums and black legs which are so characteristic, are long in making their appearance; and in the absence of such patent indications, the vague muscular pains and unaccountable languor, not accompanied by fever or emaciation or loss of appetite, are symptoms too often regarded with suspicion or contempt. Singularly enough, the scorbutic *ulcer*, of which in the systematic writers we hear so much, is at present very rarely seen even in the worst cases.

The more experienced or shrewder captains may treat the cases as scurvy from the beginning, but the means at their disposal are very limited. The muddy remains of the lime-juice are inert, and are given in double doses to no purpose. Citric acid or the nitrate of potash with vinegar are the other remedies in vogue. Purgatives and Dover's powder appear also to be largely used. Beer and pickles are sent from the cabin, but at this period of the voyage the stores there are already low or exhausted; the opportunity of replenishing them at the Cape or St. Helena has been neglected, and little can be afforded. Details of the treatment of each case are recorded, as required by law, in the official log book.

The results are not encouraging, and when the ship, delayed perhaps by baffling winds, arrives in the Thames, the unhappy patients are often in a most deplorable plight, and have to be hoisted on board the *Dreadnought* in a state of extreme prostration, unable, from the state of their mouths, to take any but soft or liquid food. Death sometimes ensues—its mode being by syncope, after some slight exertion. The greatest care is therefore taken to keep the patients tranquil. Another sad result occasionally seen is irremediable; stiffness and contraction of the joints. But as a rule the simple treatment employed operates as a charm, and re-stores the sufferer in a few days or weeks to such enjoyment of life as he has long been a stranger to. The decks of the *Dreadnought* are regarded as a very paradise by those rescued wayfarers. Perfect recovery, however, is not a uniform consequence. Dr. Barnes, who on this subject speaks with the authority derived from an immense experience, has expressed his belief that "the physical deterioration of sailors from the modified starvation which culminates in scurvy is very great. The constitution that has once yielded to it is so far damaged that any latent predisposition to other disease, as to phthisis, is apt to acquire ascendancy and to hurry the victim to an untimely end. Of those who recover, many do so imperfectly."

The same axiom holds good with regard to the other great scourge of mariners (to which I called the attention of the Society two years ago), and which, to the disgrace of our civilisation, flourishes in rankest luxuriance in this port of London. We have seen how the syphilitic taint exposes to the attack of scurvy, and how, in the re-action, the blood-disease comes as an ally to strengthen the hold, both of syphilis and tuberculosis. The apostrophe of the poet is as true now as when it was written,—

> "Poor child of danger, nursling of the storm;
> Sad are the woes that wreck thy manly form!"

Actuated by humane and patriotic motives, the Seaman's Hospital Society have for some time fulfilled the important duty of reporting to the Board of Trade all such cases of scurvy as may be considered fairly referable to culpable neglect. For example, when two or more cases are received from a vessel with a crew not exceeding twenty men, the presumption is that the state of that vessel as to diet and other matters has been objectionable. On these representations the Board directs an inspection of the vessel and its various stores, and an inquiry into all the circumstances of the crew which may have led to such results. The master, officers, and crew are examined, as well as the patients on board the *Dreadnought*, and the entries in the log book concerning the sick are carefully scanned. The evidence is often very contradictory, ill feeling on both sides showing itself in discordant statements as to the simple facts. Sometimes the provisions and lime-juice are all consumed, and no opinion can be formed thereon. The crews are sometimes dispersed before the inspection can take place; thus, important links in the chain of evidence are sometimes wanting; yet the details of mismanagement elicited by these

inspections simply prove the necessity for them, and also for remedial measures of a preventive kind.

Six of these reports, with some others from the out-ports, were printed by order of the last parliament, and since then I have been again engaged on eight inquiries of similar character. In all these I had the valuable co-operation of Mr. Coleman, of the Registration of Seamen Office, who possesses an unrivalled knowledge and experience of the Merchant Shipping Act and its workings.

If time had permitted I would have placed some of these reports before the Society; but the facts, and the conclusions based on them, have been already discussed at considerable length. And we shall now come to the question as to how these crying evils shall be remedied. With all its admirable provisions, the Merchant Shipping Act of 1854 is defective; first, in not prescribing a dietary for seamen, of which fresh vegetables, or the best substitutes for them, should be positively enjoined as part; secondly, in not insisting that lime-juice should be served out *every day* on which fresh vegetables are not issued; and thirdly, in not providing that the lime-juice shall be ascertained to be of good quality, and supplied in such a form as to be reliable, for at least two years, as an anti-scorbutic.

The powers of the central government in this matter are at present limited. They can institute inquiries (such as these) to detect abuses, but not to prevent them. The local marine boards might, if they chose, cause inspections as to the quantity and quality of anti-scorbutics while being supplied before the voyage. The Board of Trade, recognising the great importance of *preventive* inspections, suggested the appointment of a medical officer for that purpose, at the ports of London, Liverpool, Dundee, Glasgow, Greenock, Hull, Newcastle, Shields, and Sunderland. But with the exception of London and Hull the replies of the local marine boards were decidedly unfavourable. The reasons they allege for being averse to such inspections are their disbelief in their necessity, the difficulty and even impracticability of carrying them out, and their tendency to interfere injuriously with the business of the port.

"Unless the inspection be general," writes the Sunderland Board, "it would be throwing a most invidious duty upon the Superintendent of the Mercantile Marine Office to authorise him to select cases for inspection, and the Board are unable to conceive the existence of circumstances which would (except in extreme cases) justify his doing so. It would be sure to create great dissatisfaction, and might expose the superintendent to the suspicion of being actuated by personal antipathies. If, on the other hand, the inspection were general, the inconvenience would become so great, that it would be all but impracticable."

I may observe that it is mainly from these very ports that our scurvy-tainted ships do come. Out of fifty-five cases admitted into the *Dreadnought* from ships belonging to British ports, eight were from Sunderland alone.

Only three months ago I inspected a vessel which sailed from that port, in whose crew, of only nineteen in all, two deaths occurred in the Thames from scurvy, and four others were a long while in the hospital ship suffering dreadfully from that cruel disease. The lime-juice, the master stated, was procured at Sunderland and was issued regularly. Here is a specimen of it. It is nothing more than the solution of citric acid, slightly flavoured with lemon, to which I adverted a little while ago, and is I believe of little or no value as an anti-scorbutic. Another vessel (from Kurrachee) which I inspected, belonging to Stockton-on-Tees, furnished no less than eight cases—indeed, the whole crew were more more or less affected with scurvy, and those who had been hoisted on board the *Dreadnought* presented its most aggravated features. In this instance the lime-juice had been originally good, but from the faulty method of preservation had deteriorated. But it was distinctly adduced in evidence that it was irregularly taken, and that many of the crew systematically neglected it.

Another vessel which I inspected about a month ago, belonging to Liverpool, had a third of her crew disabled by scurvy, four of whom were for some time in the *Dreadnought*. Here the lime-juice was obtained from a native merchant at Calcutta, and soon spoiled, so as to be undrinkable. The disease broke out sooner than in most other cases. As no fewer than seven cases were then on the sick list, the ship called at Ascension and procured a supply of citric acid, but it failed either to relieve the sick or to prevent further extension of the malady. This is a specimen of the lime-juice, which will be found to be very offensive.

It is strange that facts like these do not carry conviction to the minds of the local authorities of our mercantile marine, and impel them to the course of action indicated by the Board of Trade.

In the absence of an official inspection, which would seem

to be the readiest and most efficacious way of meeting the case, various propositions have been entertained. As the owners and masters of ships appear to be unwilling to take the trouble to add the requisite spirit, and bottle off the lime-juice in such quantity as would insure its preservation, it seems to me desirable that licensed vendors should be required to do so; that the only form of supply should be in sealed small vessels of stone or glass; and that the sale should be accompanied by a certificate from the dealers, testifying to its purity and warranting it to keep. Respectable traders, receiving a fair price, would not decline a legal responsibility of this kind, and would, in self-defence, take greater care that the juice sold for consumption on long voyages should be of the best quality. This would do much to check the mal-practices of adulteration and manufacture which are now notoriously prevalent.

Another proposal (which seems practicable, at all events, in the larger ports), is the issue of the lime-juice to vessels only from *bond*, after being there tested and mixed with the proper amount of spirit. In this respect a slight saving would be effected, as the latter would be free from duty.

When the lime-juice is really good, and issued daily, and made into lemonade, little difficulty will, I think, be experienced in inducing the men to take it. Officers, however, should, as in the royal navy, show the good example of drinking it themselves. In the mercantile marine, those I have met with seldom or never take it; and thereby, I doubt not, unconsciously instil distrust of it into the minds of the younger hands. It is to be regretted that sounder notions on this branch of nautical hygiene should not find general acceptance. Those young officers are now, as a rule, well instructed in the science of their profession, and are often extremely able and intelligent men. Were they required to pass an examination of a simple character, on the subject of preserving the health of the crews they are destined to command, I believe a better *regime* would spring up in time, and some ideas now in vogue would become obsolete.

But, on the whole, it is to the owners rather than to the executive of the merchant navy, that we must chiefly look for corrective measures or for obstruction to them. It is obviously the interest of the captain to have his crew well fed and cared for, healthy and contented; for, without that, he cannot maintain the self-respect that is essential to discipline. But there is no doubt that, in many instances, ship owners practise a too rigid economy; and that the hopes of the masters for employment and advancement, depend too much on the parsimony with which they can conduct their owners' business and enhance their profits. I am well aware that, by many shipping firms, much attention is paid to the health and comfort of their crews; and that scurvy is as much banished from their vessels as from Her Majesty's. But it is a matter of notoriety that, before the epoch of the Merchant Shipping Act, colossal fortunes were amassed through practices almost as flagitious as those we are in the habit of reprobating among slave-trading nations. Some of that leaven remains. To quote the expressive language of one most conversant with the subject, Dr. Barnes:—"The plight in which the poor sailors from certain services are admitted is pitiable to witness. Disabled by hardship, semi-starvation, and ill-usage of every kind, they are cast out with the same indifference with which a worn-out block would be thrown overboard. In such cases, owners and masters should be held personally liable in damages to the sailors whose health, their only possession, is injured. But, although they may have good grounds for an action at law for damages, sailors are not the kind of men to try a question of this nature for themselves."

For all parties the most eligible course would be found in state interference, and chiefly in the compulsion of preventive measures. £1 to £2 a-head in addition to the present usual supplies would procure, it is calculated, a scheme of diet resembling in variety that of emigrants, but considerably more abundant. Surely owners who desire to deal justly with servants, on whom their fortune so greatly depends, could hardly grudge such an outlay for a long oceanic voyage. Masters of ships are often strictly prohibited by their instructions from calling at the Cape of Good Hope and St. Helena on their return voyage. At the Cape at some seasons the weather in port is boisterous, and their insurance would be invalidated. But St. Helena is the most accessible of places at all times, and seems providentially designed for the refreshment of ships. Yet by almost every one of the vessels I have inspected, the island, although sighted, was passed by, and even when they were full of cases of scurvy.

We cannot wonder to find that the mortality in the mercantile marine is very great even as calculated on the present data, which are confessedly imperfect. My late friend and predecessor, Dr. McWilliam, estimated it from the records

of the Registration Office at about nineteen per thousand. But in truth it is considerably greater, for no account is there taken of the many hundreds who die unknown abroad, or who have to quit the service on account of disease contracted in it, and perish miserably at their own homes or in our civil hospitals and workhouses. It is admitted on all hands that a gradual but sure deterioration of this great body of men (about 250,000 in number) has been going on for some time, and gloomy prophets predict the possible extinction of the class. Certain it is that the adventurous youths of our country find a better vent for their energies in colonial enterprise and other pursuits, and we do not find either in the royal or merchant navy men of the same stamp as formerly. In the latter their place is supplied with thousands of foreigners, chiefly of the Scandinavian and German nations, who are attracted by the high rate of pay; they are considered by most masters I have seen as valuable acquisitions. Surely it is but just that these strangers, as well as our helpless fellow-countrymen, should not suffer from the cupidity of some of their employers, and so be discouraged from a service to which they are now essential.

I perceive that in a few days, viz., on the 12th of June, 1866, a motion will be made in the House of Commons for an address for a Royal Commission "to inquire into the present condition of merchant seamen with the view of ascertaining whether within the last thirty years the supply of British seamen has fallen off either in point of number or efficiency, and if in either a continuous decline should be apparent, then to ascertain further what are the causes which have led to such decline, and whether any remedy can be suggested."

I trust I have succeeded in my endeavour to exhibit one of the causes of this unsatisfactory state of things, and the obvious and easy remedies. Let us hope for speedy legislative action to amend the existing laws. Meanwhile, an expression of opinion from this Society on a matter of national importance cannot fail to give a valuable impetus to the movement. The recent enactments concerning the other great scourge of seamen—venereal diseases—are encouraging, and indicate a growing interest in parliament for sanitary questions. We may expect to see scurvy doomed to extinction at sea, as it long has been on land. May the time soon come when the miseries with which we are now too familiar shall be regarded as one of the curiosities of medical history; in the same light as we regard the terrible scorbutic epidemics which slew whole armies, and which ravaged portions of the northern and central countries of Europe, from the time of the Crusaders to that of Frederick the Great, and of which we had recently a painful reminder in the Crimean war. Guided by the experience of that disastrous campaign (in elucidating which our distinguished ex-President, Dr. G. Milroy, had so great a share), we may reasonably infer that a similar calamity to the national force is not likely to recur. It is time that equal solicitude be shown for the welfare of those who constitute no small element of our naval force, and contribute so largely to the wealth and prosperity of the nation.

EUROPEAN CHILD-LIFE

IN

BENGAL

BY

J. FAYRER, C.S.I., M.D., F.R.C.P.

BENGAL MEDICAL SERVICE.

LONDON

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EUROPEAN CHILD-LIFE IN BENGAL.

THE subject of infant European life and health in British India must always be one of considerable interest, especially now when that country is becoming so great a field for European enterprise; and it is one, therefore, upon which accurate information is most desirable. For where can we find a city, town, village or community—I might almost say family—in England in which some one does not look towards India with interest, or expect with anxiety the arrival of each weekly mail that may bring tidings of relatives or friends in the far East? And this interest is daily enlarging among all classes, not so much from the extension of our empire in the East, as on account of the impulse recently given to various industries and arts, and to the development of the almost boundless resources of that great peninsula, which is calling for and giving employment to all classes of our countrymen.

The European infant population is no doubt rapidly increasing in India, and all that concerns its life and health must therefore be of great social as well as sanitary interest. As the missionary, the schoolmaster, the railway, the telegraph, and the printing-press exercise their inevitable influence on civilization and on the development of the intellectual no less than the physical resources of the more remote as well as of the more central parts of the empire, so is an ever-increasing tide of Europeans, by whose aid these ends are attained, attracted thereby; for although native agency and labour are, and always must be, mainly relied on, it is found that European supervision and skill are indispensable, and that their supply increases in proportion to the demand.

Matters have changed in respect of the condition of the Anglo-Saxon in India during the last quarter or half a century; or to date from an earlier period, one might say since the days when Europeans not in the covenanted service of the Honourable East India Company were looked upon and styled interlopers and adventurers, and were permitted to remain in the country only on sufferance, being at any time liable to expulsion.

The position of the European resident in India of those days was very different from that of his countryman now. In some respects, perhaps, he had greater, though in many he had certainly less, advantages than his successors. If he had the opportunity of gaining greater wealth, more power, prestige, and of leading a more luxurious life, his voyage to India was seldom accomplished by the long and tedious sea route round the Cape in less, often in more, than from four to six months. If on his arrival in the country he found himself placed, even in youth, in an office of considerable responsibility, dignity, or much emolument; and if his life were one of Oriental luxury (a condition, by the way, which is grievously over-rated), yet he was cut off from his family and friends, and his communications with them were so few and at such long intervals that he gradually became isolated from home and its influences as much in mind as in person; and it is no exaggeration to say that this expatria-

tion was not more conducive to his moral than to his physical welfare.

All this is altered now. He reaches India from England in three weeks; he goes, if he will, from Calcutta to Simla in as many days; or, if he can afford it and feel so inclined, he may take leave, and, having spent half of the time in China or England, can be back in India by the expiry of three months—in less time than it formerly took him to go from England to Calcutta. The moral and social atmosphere in which he lives has changed, as might be expected: he lives more under the influence of home interests and impressions, and in all respects his life is different from that of the Anglo-Indian of former days. He has weekly communication with home by letters, daily by telegraph; he has all the new books, periodicals, reviews, journals but little later than they are to be found in the reading rooms of remote parts of the United Kingdom. He has all that is new in art, science, and literature—the railway, the telegraph, the penny (anna) post, gas, ice, theatres, museums, social and scientific societies, opera, clubs, circulating libraries—all that he could have in England; not quite so good, perhaps, as in London, but still sufficient to make life in India as tolerable as heat, malaria, damp, mosquitoes, and the dread of cholera will permit.

It is seldom much good occurs without bringing in its train some evil; nor have we any exception here. The European class in India is no longer confined to the covenanted *employés* of former years. The so-called "adventurer" class has increased: and by this I do not mean the merchant, the planter, the tradesman; these, like their covenanted and uncovenanted service brethren, are well enough as a general rule provided for, and well-to-do—free from the "*res angusta domi*." I allude rather to the artisans, who are now numerous enough in India, on the railways, in factories, and engaged in many subordinate offices formerly held by natives, and on whom and their families the necessities of life press hard enough in such a climate, and who have, in addition to the disadvantages natural to it, all the anxieties inseparable from the care of a family to contend with.

Among other improvements resulting from the spread of knowledge and the advance of science, those of a sanitary nature have not been of the least importance, for they are diminishing the death-rate and raising the standard of European health in India. I do not intend to refer to figures and statistics further than by a brief reference to the last report of the Sanitary Commission: those who care to study this question may do so by referring to the sanitary reports published by the Indian Government. Sufficient for the present to say that some improvement has taken place, and that European life is becoming more valuable than it used to be. I speak chiefly from the experience of military life—that is, of the British soldier—for so far as I know the only reliable health statistics are those relating to the sanitary condition of the army; but the principle applies to all, and among others, to the children.

Dr. Cunningham says, "It may be observed that the experience of the year 1871 has, on the whole, been favourable. In the case of Bengal this remark is peculiarly apt, for here in no year of which there is any accurate record has the mortality been so low. The death-rates in this Presidency for each year since 1858 are shown in the annexed statement, and the ratios for Madras and Bombay have also been included, so far as I have been able to obtain the required information.

Statement showing the Mortality per 1000 of Average Strength among European Troops in the Three Presidencies during 1871, compared with that of each year since 1858.

Years.	Bengal. *				Madras. †				Bombay. ‡			
	Cholera.	All other causes.		Total.	Cholera.	All other causes.		Total.	Cholera.	All other causes.		Total.
		In hospital.	Out of hospital.			In hospital.	Out of hospital.			In hospital.	Out of hospital.	
1858	9·16	91·39	10·52	111·07	§	..	..	..	§	..	..	..
1859	8·67	35·30	1·38	45·35	..	..	..	..	..	..	..	..
1860	12·04	24·14	·59	36·77	..	19·1	2·04	21·14	..	..	..	31·70
1861	23·73	21·06	1·14	45·93	..	14·5	1·8	16·3	..	..	..	24·72
1862	9·61	17·44	1·06	28·11	..	17·09	1·7	18·16	..	..	..	24·60
1863	4·09	18·85	1·18	24·12	..	16·5	3·01	19·51	..	..	..	16·14
1864	2·55	17·39	1·16	21·10	..	16·5	3·6	20·1	..	14·4	1·5	15·9
1865	3·12	20·40	·72	24·24	..	19·5	2·9	22·4	16·0	17·8	1·3	35·1
1866	1·37	17·34	1·40	20·11	2·3	17·9	1·5	21·7	0·6	10·7	1·4	12·7
1867	13·84	16·16	·95	30·95	0·36	15·34	2·3	18·0	5·0	12·4	1·9	19·3
1868	1·81	16·94	1·36	20·11	0·5	15·8	3·0	19·3	0·8	12·1	1·0	13·9
1869	16·46	24·98	1·45	42·89	2·2	18·8	2·3	23·3	5·2	13·7	2·5	21·4
1870	·63	19·74	1·53	21·90	3·5	13·4	2·3	19·2	0·1	15·3	1·3	16·7
1871	·71	16·07	1·05	17·83	3·32	15·40	1·38	20·10	·09	13·10	·83	14·02

"The death rate for Bengal in the past year—17·83 per 1000—although lower than it has ever been previously, is still above the ratio which has been attained in the other Presidencies, and specially in Bombay. The marked fluctuations in the Bengal mortality, chiefly due to cholera, contrast as a rule with the comparatively steady proportion of deaths in both Madras and Bombay."

* From Dr. Bryden's tables.

† From 1860-70, Sanitary Commissioner for Madras, Report for 1870, page 2; for 1871, Dr. Bryden.

‡ From 1860-63, Army Medical Reports; 1864-70, Report of Sanitary Commissioner, Bombay, for 1870; page 12, for 1871, Dr. Bryden.

§ The proportion of the deaths due to cholera in the Madras and Bombay Presidencies cannot be shown for the early years. The figures in these columns have been supplied by the Sanitary Commissioners.

The death-rate of British troops in India in 1871 was only $17\frac{1}{2}$ per 1000; of officers 12·49 per 1000.

According to Dr. Townshend—

Mortality of Ten Years—1860-69.

	Max.	Min.	Mean.
Men	45·93	20·11	29·98
Women	68·03	25·46	43·31
Children	145·22	71·36	94·90

1870.

	Strength.	Deaths per 1000.
Men	33·373	21·90
Women	3·519	32·68
Children	5·644	81·68

Deaths of Children per 1000.

	England. Mean of 29 years, 1838 to 1866.	Bengal. Presidency. 1870.
Under 5 years ..	67·58	148·10
5 and under 10 years	8·80	17·73
10 " 15 "	4·98	11·51

It has often been asked if the Anglo-Saxon can colonize India—*i.e.* can the race unsupported and unrecruited from home continue to reproduce itself and exist there? Can he, in short, do in India what he has done in America, Australia, —colonize or establish himself, take root, continue his race, people the country, and of course in so doing displace, or rather replace, the autochthones, and his older Aryan brethren, who have become acclimatized during an occupation of many centuries? I think not. But if I am asked, Why not? I must admit that I have no proof to give that it would be so, and that I have only my impressions to offer in support of the conviction, as the data for framing a precise reply do not, so far as I know, exist. I am not aware that the opportunity of testing the vitality and durability of the Anglo-Saxon race cut off from all communication with its own country or with the in-

digenous races has ever occurred; but I feel convinced that, had India been colonizable by the European, his position, important though it be, would have been very different to what it actually is. This, however, though a curious and important point of ethnic inquiry, is not the subject now to be discussed. I desire to consider, not the question whether the Anglo-Saxon can colonize India, but whether he can rear his children—the first generation—in that country, and with what prospect of success?

Sanitary science is doing much: life is being prolonged; health and the conditions of existence are altogether being improved. The European who becomes an item in the fixed population, who leads an ordinarily temperate and correct life, has expectations of life perhaps little below those he might have had in England. But still he is in a tropical or quasi-tropical climate, he is liable to certain grave and sudden disorders, he incurs a risk which has been variously estimated by life insurance societies, all implying greater danger to life than in England. This would be a question, also, of interest, and one that might furnish subject for profitable investigation.

But, as I have said, it is not of himself that I now wish to speak, but of his children, and especially of those whose parents are unable, from any cause, to send them to Europe for nurture and education. What are their chances of life and health, brought up and trained in India?

Now, with reference to the rearing of European children in India, much has been done during the last half-century. The necessity for proper schools, and establishments where not only their physical but their moral health would be regarded, has been the subject of serious thought, attention, and action of many good and great men in India, and has led to the establishment of schools and orphan asylums in the Presidency and other towns and hill stations, which have contributed much to these good ends; and the various orphan asylums and schools in Calcutta—the Lawrence Asylum at Sanawar, and the Bishop's schools in the hill stations—will, as long as we remain in India, bring down with grateful remembrance to posterity the names of Claud Martin, Ellerton, Kidd, Sir H. Lawrence, Bishop Cotton, and others.

In these institutions the problem of infant health and progress in India is solved to a certain extent; but as a reply to the essential question I wish now to consider, that of European infant health, it is only partially satisfactory, for the reasons that, in the first place, some of the schools are situated in the hills, in an almost European climate; in the second, the children are to a great extent of mixed parentage.

The introduction of the indigenous race element of course entirely modifies the value of the information we thus receive. An opportunity, however, does exist in Calcutta of studying this very important question, and it would hardly be possible to imagine one better calculated to illustrate the subject.

In or about the year 1815 an asylum was founded in Calcutta for the female orphans of Europeans of the poorer classes in India, and the original reasons for it are set forth as follows in the annual report of the institution :—

"It has long been observed, by persons whose situations have enabled them to know the state of the children in the King's European regiments in this country, that those who become orphans at a very tender age, being usually left in the charge of careless nurses, and in many cases altogether unprovided with nurses, are very seldom reared to maturity, through the ignorance, indolence, and cruelty of those who

are entrusted with their management. An asylum, therefore, for the reception of such orphans would tend to the preservation of many lives which are now lost through the neglect or mismanagement of nurses, or the want of nursing altogether.

"1. This Asylum is established for the reception and education of female European orphans generally, but especially those of the King's regiments in India.

"2. Those children only are admissible whose fathers and mothers are both Europeans.

"3. The objects of this charity are admissible (if under 10) whenever they become orphans, at however early an age.

"4. That destitute children deprived either of one or both parents be eligible to the benefits of the institution, until the number reach to the amount of one hundred."

Originally intended for the orphan children of soldiers in the King's regiments (the only class of Europeans then in the country whose circumstances were so poor as to render it impossible for them to make provision for their children in case of death), it has of late years become of much wider application, for the class of Europeans who may require such a provision for their children is, and has been, as I have before said, increasing, and for many years a large proportion of its inmates have not been the children of soldiers—these being for the most part provided for by the Lawrence Asylum or other institutions founded of later years.

I would observe that this European Orphan Asylum differs from all the others in this respect, that it extends its benefits to children of pure Europeans only—any mixture of native blood rendering the child ineligible. The question of the growth, nurture, and vital statistics of the *Eurasian* child is one of great interest, but is apart from that with which I am now concerned.

It is this which gives it such value as a crucial test in studying the influence of climate in the growth and development of the European child, and is the reason why I have selected it as the basis on which the following remarks are made. The report on which these remarks are chiefly based commences in January, 1863, and is continued up to May, 1871, or for more than eight years, and also on the previous history for many years as related by the Secretary and confirmed by letters from Drs. Jackson and Webb.

It appears from these records that about 130 individuals have been under observation during this period, ranging in age from 1 year to 18 years—a daily average of about sixty-five girls. Say that in January, 1863, there were sixty-six in the institution; to these, before May, 1871, were added sixty-four, and of that number seventy had left. During this period there have been six deaths —one in 1863 from dysenteric diarrhœa, one in 1865 from mesenteric disease, one in 1866 after amputation, one in 1866 from convulsions in teething, one in 1868 from typhoid, and one in 1868 from atelectasis pulmonum.

It is remarkable how great an immunity these children have had, not only from the diseases peculiar to the country, but from all others of a severe kind. There has been during the period under report, and for many years previously, I believe, no cholera, no diphtheria, no scarlatina, no croup, no pleurisy, no pneumonia, no ophthalmia, no typhus, no phthisis, no severe malarious fever or its complications, no dengue, and no malarious cachexia. The diseases have been—a few cases of dysentery, one only fatal, in a child (a mistress died of that disease); a few cases of diarrhœa, simple fever, febricula; a few cases of typhoid (one death), slight rubeoloid,

slight hooping-cough; a few cases of modified small-pox—varicella; some catarrhal and bronchial affections; herpes, abscess, stomatitis, slight conjunctivitis, convulsions, simple sores.

SANITARY REPORT OF THE EUROPEAN FEMALE ORPHAN ASYLUM FOR SIX YEARS, COMMENCING JANUARY, 1863.

During this period the monthly average of each year of the number of girls in the school has been, in round numbers—In 1863, 68; in 1864, 70; in 1865, 67; in 1866, 66; in 1867, 59; in 1868, 60—being an average of 65. The ages vary from 1 to 18 years, the great proportion being between the ages of 5 and 16.

The sanitary history of this institution is as gratifying as it has been during previous years, and is not less remarkable for the absence of disease than for the generally vigorous state of health enjoyed by the inmates. The abstracts of admission into hospital show that there has been great immunity from epidemic disease of any severity, and the very low mortality, as well as the small amount of sickness, proves that the European child, under proper hygienic conditions and careful physical training, may live and thrive in the plains of Bengal *almost* as well as in its native country. It is not merely in the absence of any serious disease and the low death-rate that this is manifested, but in the vigorous, healthy appearance of the children generally. This was remarkably noticeable at the last yearly distribution of prizes, when the girls were assembled; and it is no exaggeration to say that their appearance on that occasion would have borne favourable comparison with that of the girls in any similar institution in Europe.

For this very satisfactory state of matters the thanks of all interested in the institution are due to the careful and judicious management of the Ladies' Committee, who have supervised the institution, and especially to the lady superintendents, who have, under their directions, so vigilantly watched over the moral, mental, and physical education of their charges. It is impossible too highly to estimate the advantages of such management, and I am glad to have this opportunity of recording my impressions on the subject, and of declaring how much the high state of efficiency of the school, as well as the continued good health of its inmates, is due to the unwearied exertions and admirable administration of the past and present Lady Superintendents.

Disease during Six Years: Daily Average about Sixty-five Children.

Abscess	2	Icterus	2
Adenitis	2	Lumbrici	1
Œdema	2	Marasmus	2
Anæmia	1	Operatio	1
Aphthæ	1	Parulis	2
Bronchitis	1	Pleurodynia	1
Catarrh	24	Pneumonia	1
Cephalalgia	1	Rubeoloid	29
Conjunctivitis	5	Scabies	3
Convulsio	2	Sprained ankle	2
Curvature of spine	1	Stomatitis	3
Cynanche	3	Subluxatio	1
Debilitas	3	Torticollis	1
Diarrhœa	81	Tuberculosis	1
Dysenteria	15	Tumor	1
Dyspepsia	16	Ulcus	3
Febris (simp.)	77	Vaccinia	2
Febris (typhoid)	2	Varicella	4
Febricula	5	Varioloid	2
Furunculus	33	Vulnus capitis	2
Herpes	49	Vulnus digiti	1

There are several points of interest in the sanitary history of this school that might be considered, but I shall only advert to those which are most appropriate to this brief report. And first I would remark on the absence of any severe form of

epidemic disease. In looking over the monthly abstracts of admissions into hospital, I find that there has not been a single case of cholera; and that the only death from dysentery, which is the disease peculiarly to be dreaded in Calcutta, was that of ——, aged 5 years, which occurred in 1863, and this was rather a case of dysenteric diarrhœa in a naturally delicate child.

With reference to the class of disorders peculiar to early female life, I may say on this head that nothing could be more favourable, and that although there be certain indications of the influence of climate in either accelerating or modifying the usual functions, the state of health of the girls is, in this respect, most satisfactory.

The disease returned as measles was a rubeoloid fever of a mild form, slightly contagious, showing little tendency to spread, which has occurred from time to time, and has not been followed in any case by those grave sequelæ that so frequently result from measles in Europe.

Two cases of modified small-pox only are recorded, and there has never been any tendency in the disease to spread. The children have all been protected by vaccination, which has succeeded admirably in all upon whom it had not previously been tried.

A few cases of genuine typhoid or enteric fever have occurred, one of which proved fatal in 1868, the case of ———, aged 5. The other forms of fever have been of the simple continued form, or mild manifestations of the influence of malaria.

The same may be said of the cases of convulsions, a few of which have occurred.

Hooping-cough has been altogether absent.

A few cases of skin disease, but those of a simple and tractable kind, have occurred.

As might be expected among so large a number of children, strumous disease has not been altogether absent, and one death from pyæmia in the Medical College Hospital after amputation of the thigh, the other thigh having been previously amputated a year before, for extensive disease of the knee-joint; and another from marasmus, the result of strumous disease of the mesenteric glands, have been recorded.

Of acute inflammatory disease, whether of the head, chest, or abdomen, there has been almost none.

Diseases of the liver or spleen, whether from malaria or other causes, have been also singularly few, if not altogether absent.

Pulmonary and bronchial complaints have been very few and slight; with the exception of one case of capillary bronchitis with atelectasis in a child aged fourteen months, who came in ill and died a week after admission; and a few slight catarrhal attacks involving the bronchial tubes,—none are recorded. Indeed the mildness of disease and the absence of those forms of it, with few exceptions, that characterize the Indian climate, have been remarkable.

The number of children under two years of age has been small, and therefore it is not to be expected that the diseases of first dentition should occupy a marked place; indeed, they have been almost altogether absent. The cases of convulsions recorded wer edue more probably to either centric irritation or the influence of malaria on the nerve-centres. But the evidences of malaria have been, on the whole, I am bound to say, very slight, as may be readily seen in the fresh colour and red lips of the children.

I would here remark, in proof of the improved sanitary condition of the girls, that lateral spinal curvature, of which ten years ago there were several cases, has now disappeared from the school. There can be no doubt that the very satisfactory state of health enjoyed by these children is mainly due to the sound hygienic arrangements, and the moral as

well as physical discipline under which they live. They inhabit a well-built, ventilated, and commodious house, surrounded by a large open space of garden or ground, in which they find amusement and healthy recreation in gardening, or play in the open air. The nature of their occupation is such as to conduce alike to their moral and physical well-being. They have sufficient mental labour to develope without fatiguing their intellects, and of a character suited to the sphere of life in which they are intended to live. With this is combined methodic occupation of a fitting character, regular hours, a good but plain and nutritious diet; and all that could tend to injure the health from constant or overwork of any special kind is strictly avoided.

The following statement of their daily occupations, diet, and recreation by the Lady Superintendent, explains how the time is passed; and it is a system that might well be followed by other educational establishments here and elsewhere.

Diet.—Three regular meals in the day, and bread early in the morning. Breakfast (half-past nine), bread and milk. Dinner (half-past two), meat every day for girls above twelve, and three times a week for those under; dhall and rice, etc.; fruit three days in the week. Supper (half-past seven), bread and milk. The milk is pure; no water with it.

Habits.—All through the year the children rise at five a.m., bathe in cold water, and then take exercise in the compound.

Occupation.—During the cold season school commences at seven, and in the hot weather at six a.m. Five hours of regular school, and one of study (preparing lessons) through the day. During the hours of recreation, skipping and active play are encouraged, and, as a rule, the children are as active and fond of a good romp as children in England. In-door exercise consists of cleaning the house, which is all done by the girls. Calisthenic exercises every morning.

The conditions of a healthy mind in a healthy body are here all existent, and the results show how materially a just combination of mental and physical training will, when supported by example in those whose duty it is to teach, conduce, even in the climate of Bengal, to ensure a high standard of moral and physical health.

In reference to the question of growth and development of the European child brought up and educated in Bengal, I may give the following illustration from the average measurements of five girls at sixteen years of age, which was—height, 5 feet 4½ inches; weight, 7 stone, 11 pounds; girth of chest, 34·7 inches; girth of hips, 35·7 inches—a stature and weight which would probably not be much exceeded in Europe.

During the next twenty-eight months—*i.e.*, from January, 1869, to May, 1871, the health of the school was excellent. Disease has been almost entirely absent; the general standard of health has been high. There has been no death. But two cases of any severity have occurred; one of pelvic abscess, from which, after an operation, the girl recovered, and is now in robust health; another had typhoid fever rather severely, but recovered. I would notice one or two causes, which are, no doubt, potential in preserving health, and have recently been introduced. First, the children now all wear flannel, and have a blanket at night under the sheet on which they sleep; and, secondly, they drink the new water from the stand-pipe. Both of these changes are beneficial. The absence of disease and the general good health that have prevailed is somewhat remarkable in a school of nearly seventy girls. In 1869 there was a slight outbreak of measles in January. Eight girls only were affected, and there were no unpleasant sequelæ. Except the two cases already alluded to, there was absolutely no other disease in this year. In 1870 there were a few cases of varicella; and in July, two cases of typhoid fever; both recovered. There was no other disease during 1870. Up to the date of the report

(May 6, 1871)*, there has been almost no sickness, with the exception of a few very slight cases of hooping-cough. The disease was clearly imported by one of the girls who had been out on leave. The cases are mild, and it shows no inclination to spread. Throughout the whole period there has been no small-pox; the children are all protected by vaccination.

The following table shows the ages at which each of twenty-seven girls commenced to menstruate. These girls are all of pure European lineage, such being a condition of their admission into the Asylum. It appears that seventeen were born in India, two in Ceylon, six in Europe, one in Australia, and one whose birth-place is not known. The earliest age at which the catamenia appeared was at 12 years and 2 months in a girl born in India; the latest at 16 years and 4 months in the case of a delicate strumous girl who died, after amputation (in the Medical College Hospital), of pyæmia; she was also born in India. The next latest was a girl born in England, in whom it commenced at 15 years and 8 months. Of the seventeen girls born in India, the catamenia commenced in two between 12 and 13; in five between 13 and 14; in eight between 14 and 15; in one between 15 and 16; and in one between 16 and 17. Of the six born in Europe, the catamenia commenced in one between 12 and 13; in one between 13 and 14; in two between 14 and 15; and in two between 15 and 16. Of the two born in Ceylon, it commenced in both between 13 and 14. One in Australia, between 15 and 16; and the one whose birth-place was unknown, between 12 and 13. Thus of the whole number—

Four	commenced	between	12 and 13	years of age.
Eight	"	"	13 and 14	"
Nine	"	"	14 and 15	"
Five	"	"	15 and 16	"
One	"	"	16 and 17	"

* This state continued until I left India in March, 1872.

Tabular Statement showing the Birth-place, Date of Birth, and Age at which the Catamenia first appeared in Twenty-seven Girls of European Lineage, educated and brought up (many born) in India.

Where born.	Date of birth.	Date of first menstruation.	Age.	Remarks.
India	March 3, 1851	March 13, 1864	13 years 10 days	Regular (left school).
India	October 20, 1850	April 1, 1864	13 years 5 months 11 days	Regular.
India	October 19, 1851	December 21, 1864	13 years 2 months 2 days	Irregular (left school).
India	September 28, 1848	February 10, 1865	16 years 4 months	Illness occurred twice (dead). Died March, 1867.
India	January 14, 1852	September 15, 1865	13 years 9 months	Regular.
India	July 27, 1854	October 10, 1866	12 years 2 months	Regular.
Ceylon	January 11, 1852	October 17, 1866	13 years 9 months	Regular.
England	November 11, 1852	December 3, 1866	14 years 19 days	Regular.
India	November 18, 1852	January 9, 1867	14 years 1 month	Regular.
India	April 23, 1853	January 12, 1867	13 years 9 months	Regular (left school).
India	June 9, 1852	March 27, 1867	14 years 10 months	Very irregular (left school).
England	June 18, 1852	November 5, 1867	15 years 5 months	Regular (left school).
Scotland	April 28, 1853	January 4, 1868	14 years 8 months	Regular.
India	January 7, 1853	December 28, 1867	15 years all but a week	Slightly irregular.
India	December 5, 1854	January 12, 1868	14 years 5 weeks	Regular.
India	August 12, 1852	February 1, 1868	15 years 5 months	Regular (left school).
England	May 15, 1854	March 8, 1868	13 years 10 months	Regular.
India	March 15, 1854	April 27, 1868	14 years 1 month	Regular.
Australia	August 10, 1853	September 28, 1868	15 years 1 month	Regular.
Ceylon	April 20, 1855	October 3, 1868	13 years 5 months	Regular.
India	May 5, 1854	October 11, 1868	14 years 5 months	Illness has occurred only once.
Not known ..	May 14, 1856	December 17, 1868	12 years 7 months	Regular and very profuse.
India	August 3, 1855	April 6, 1869	14 years 7 months	Regular.
India	May 25, 1856	February 6, 1869	12 years 8 months	Regular.
India	March 30, 1855	June 10, 1869	14 years 2 months	Regular.
England	December 21, 1856	June 12, 1869	12 years 5 months	Regular.
England	November 17, 1853	August 10, 1869	15 years 8 months	Regular.

The column of remarks in the table shows how the functions were performed subsequently. This is interesting as showing how far physical and moral training under favourable circumstances affect the European female child born and brought up in India.

I have been acquainted with these girls since they were young children, and the impression I have formed is, that they are rather more precocious both in physical and mental development than girls of the same age would be in Europe. They are most carefully educated, and, as the Report shows, their physical as well as moral training is most sedulously guarded from aught that could prejudice or injure either. But the stimulating effects of an almost tropical climate assert their influence; and it is evident that the girl of 16 or 17 is two or three years in advance of a girl of that age in a European climate. It is remarkable how few deviations have occurred from the natural and regular performance in the menstrual functions in these girls. As a rule it occurs regularly and without trouble, and it is most unusual to hear any complaint made on this score.

In connection, though perhaps remotely, with this subject, I would note the occasional occurrence among the girls of a swelling of the lower extremities evidently nearly allied to the elephantoid growth seen in the limbs of the natives of Bengal —a bucnemia. It is manifestly a steady and progressive enlargement about the ankle and leg, but extending slightly up the thigh itself, generally on only one side. If there be any change in the condition, it occurs at the menstrual period, when the limb is somewhat larger than at other times. The swelling is firm, not œdematous, and very like elephantiasis, except that it is not attended with either periodic pain or excitement in the parts, but is of very slow and steady growth. One of the finest girls (aged 17) in the school is affected by it, and the left ankle is more than an inch greater in circumference than the right, and the swelling gradually extends to the left thigh, which is somewhat larger than the right. There is no pain and very little inconvenience, except that which comes from the increased size. I have not, as yet, succeeded in making any impression on it by medical treatment, and but very slight—only of a temporary nature—by bandaging. These cases, I am happy to say, are exceedingly rare, as during the twelve years that I have known the school, there have been only two or three; they are very interesting, and their pathology requires further investigation.

My personal knowledge of the institution ranges over a period of twelve years—*i.e.*, from 1860 to 1872,—and I have been, through the kindness of the Secretary, furnished with sufficient information as to the early history of the school to show that it has been equally satisfactory. The Secretary says, "I can't remember any sickly year with the above exception. I have known single cases of cholera, but none fatal; no outbreak of dysentery, but we have had single cases most years, but not fatal amongst the children. We lost two mistresses from death by dysentery, and one had to leave on account of that disease. I should say chronic dysentery, diarrhœa, and sluggish livers were the commonest ailments of the children. I never heard of diphtheria in the school. One of my earliest recollections of illness in the school was a very severe fever of the nature of typhus, I believe (which caused great anxiety), in a girl of 10, who became very delirious and lost her speech for weeks, but ultimately recovered, and no one else took the fever. My personal recollection of the European Female Orphan Asylum goes back to 1850. The only epidemic I remember besides measles and hooping-cough—one or other of which has visited the Asylum mildly every two or three years—was chicken-pock; in what year I can't

now recall, but it must have been pretty general through the school, for I remember the chapel was filled with beds as an additional hospital, and there was some anxiety, from the idea that it was modified small-pox, but no deaths occurred." The following letters from Dr. Webb and Dr. Jackson confirm this:—

Letter from Dr. Allan Webb to the Secretary of the European Female Orphan Asylum—1852.

"Having had medical charge of the European Female Orphan Asylum during the years 1849, 1850, and 1851, I have had abundant opportunity of judging of its general healthiness, and comparing it with other educational institutions for children in Calcutta. It must be, to all connected with this admirable institution, most gratifying to learn that the children are so healthy; that there is no institution in Calcutta surpassing it. I doubt if there be any in India more free from disease; and this happy result is attained—it must not be lost sight of—in children exclusively European in the climate of Bengal.

"But this testimony to the health of the girls generally is not limited to immunity from disease only, but comprehends that robust capacity for work and play which marks the well-being of a child. For this great blessing under Providence the children are indebted to the intimate personal supervision of the Lady Managers themselves in all that appertains to diet, exercise, and the neatness, cleanliness, and order which are inseparable from the salubrity of a girls' school; the fine open grounds and large airy upper-room dormitories being very important adjuncts.

"The school has not been exempt from disease. There was a good deal of sickness in the earlier part of 1850, when small-pox and measles were raging in Calcutta, but the diseases were of a mild type in this institution; whilst of cholera I do not remember whether or not there was a single case, yet this is generally as common as it is fatal. The children were indeed wonderfully exempt from bowel complaints.

"I am, &c.,

(Signed) "ALLAN WEBB, M.D.,

"Presidency Surgeon."

Letter from Dr. J. Jackson to the Secretary of the European Female Orphan Asylum—1853.

"I have great pleasure in sending you a short notice of the state of the health of the children in the Orphan Asylum during the last year, and it is a great satisfaction to be able to state that they have been altogether free from any of the ailments which commonly are observed in schools, and that during the whole of the past year, from the month of February, when I commenced my charge, there has scarcely been a sick child in hospital.

"This is attributable, no doubt, in some measure to the children all being of European extraction, but more especially is it due to the kind and judicious management which is bestowed upon them, to the regularity of habits, goodness of their diet, and the great attention paid to cleanliness and ventilation; and I consider it impossible to find an equal number of children in a better state, or more healthy condition, in any similar institution.

"I am, &c., (Signed) J. JACKSON."

Reference to the later reports shows what is much to be regretted,—that notwithstanding its usefulness, this institution has rather fallen off in numbers of late years; that, whereas in 1853 there were eighty inmates, the number has decreased to sixty-five in 1872. Of course this is partly accounted for by the existence of other institutions; but, considering the increasing want and the advantages of this institution, it is matter of regret that there should be any falling off at all.

How much the value of infant life is affected by climate and the circumstances under which it is placed, may be seen by comparing the statistics of death of European children in England and soldiers' children in the Bengal Presidency, for which I am indebted to Dr. Townsend, Sanitary Commissioner of the Central Provinces of India, and by the statements which I have extracted from the last Indian paper (of March):—In 1871 there were nearly 11,000 soldiers' children in India, of whom 425, or about 5 per cent., were sick every day, while 794, or upwards of 7 per cent., died. The mortality, therefore, of children is thrice that of adults. Judging from the experience of 1871, the risk of life in the Bengal and Bombay Presidencies in each 100 European children is stated as follows:—thirty-three die under 6 months, twenty-two die between 6 months and 1 year, nineteen die between 1 year and 18 months, eleven die between 18 months and 2 years, two die between 2 years and 3 years, one and a-half die between 3 years and 4 years, and one between 4 years and 15 years. At this rate it is remarked, out of 100 babes, scarcely eleven would reach maturity.

For example in 1000:—

	England, the mean of twenty-nine years.	Bengal Presidency, 1870, by Report.
Under 5 years . . .	67·58	148·10
5 ,, to 10 . .	8·80	17·73
10 ,, to 15 . .	4·98	11·51

—or more than double. Now, that this mortality is due to some extent to preventible causes, and not only to climate, I think is tolerably clear, if compared with the death-rate of the European Female Orphan Asylum, where a similar class of children under better conditions gave such very different results. I am perfectly aware that statistics are only reliable in very large numbers, and that they have been said to be capable of proving almost anything; but I know that the life of the European children in barracks in India is not so safely guarded against evil as might be, and that, despite all the care and attention they receive, they are exposed to influences that tell more against life and health than is the case with children placed as those I have described in the European Female Orphan Asylum.

Miss Nightingale says justly, "Children are, as it is well known, the very touchstone—the live tests—of sanitary conditions, or sadly, but too often, the dying and dead tests of *insanitary* conditions."

That infant life and the preservation of health is peculiarly influenced by the hygienic conditions under which it exists, is proved by such facts as those I have narrated in reference to the European Female Orphan Asylum, and I would here remark that it has been shown to be equally so in England.

I am indebted to Mr. E. Chadwick, C.B., a sanitarian of European fame, for the following remarks on the subject in connection with the half-time school-drill review held on July 25, under the auspices of H.R.H. the Prince of Wales and the Society of Arts:—

"MORAL RESULTS.

"The great body of the children reviewed are orphans or deserted children. Under the old system of Poor-law

administration, the children of this class, brought up in the workhouse long-time school, in contact with aged and vicious paupers, were turned out at 13 or 14, bodily and mentally inapt for steady industry, and not above one out of three got into a place of self-supporting industry. Full 60 per cent. went to 'the bad,' on the streets as mendicants or thieves, the girls as low prostitutes, and they furnished the largest contingents to the population of the prison. These moral failures were attended by pecuniary waste, for all were supported by the ratepayers, either as mendicants or thieves, or as expensive prisoners. But now, under the improved mixed bodily and mental training of these half-time schools, the known failures and waste do not exceed 3 per cent. The great mass of the boys brought under review may be beheld with confident satisfaction as victims rescued from 'the bad,' and preserved for the good, as honest, self-supporting producers, and worthy members of the community. But although much of this success will be due to the bodily and industrial aptitudes imparted, and the work of the drill-master displayed, yet much of it will be due to the ministrations of the school chaplains, not alone in religious instruction, but in secular care and service, seeing that they get fitting places (especially girls), visiting them there, advising them, and corresponding, and acting *in loco parentis* to all the fatherless and the motherless.

"SANITARY RESULTS.

"It has been shown, as respects the common schools, where filthy-skinned and dirty-clothed children are often crowded together in ill-ventilated rooms, in miserable conditions, they are the common centres of children's epidemics. The old workhouse schools were subject to murderous epidemics. But now, by the application of rudimentary sanitary science, they are made normal examples of what may be done by it. Of this, one of the schools from whence the children were sent to the first review may be cited as an example. Some years ago, the death-rate was 10 and 11 per 1,000. The drainage and ventilation were improved, and it was then brought down to about 8 in the 1,000. Next, more complete personal ablution and a swimming-bath were established, and the death-rate was reduced to about 4 in the 1,000. All the district schools, the elder of whose children will be reviewed, are to some extent children's hospitals, and many children are taken in only to die or linger as hapless cripples for life. But—with the exception of some remains of ophthalmia—by better ventilation of space, by careful skin-cleanliness, and by bodily exercise, the 'children's diseases of spontaneous origin may be said to be banished, and the death-rates have been reduced to about 3 in the 1,000, or less than one-third of the death-rates prevalent amongst children of the middle and well-to-do classes. With such a general death-rate, producible by sanitary science, there would be upwards of 10,000 children saved annually in the metropolis. Without such sanitary precautions, new schools may be only extended centres of children's epidemics.'"

I think it will be admitted that no more delicate test could have been afforded on the question of the state of infant European health, and the chances of life in the climate of the plains of India, than this almost continuous history of a little colony of about seventy European children—of all ages from one to eighteen years, educated and trained in Calcutta and never leaving the place—for a period of more than half a century. The answer it furnishes to the question is more favourable and satisfactory than might be imagined by those who have seen the evil effects of a tropical climate on infant life, for it shows that with care and attention much may be done that might be deemed impossible. The statistics of

these children would, I know, compare favourably with those of any school in the world; and so far it is very satisfactory, for it demonstrates most clearly that with care and proper training a European child may live, grow, be educated, and even thrive in the plains of Bengal. This must be a consolation to those parents who are unable to meet the cost of sending their children to Europe, or even to the hills, and who otherwise must have the misery of feeling that their children were sacrificed to the inevitable hardship of having to remain in the plains. Having said so much, I have something to say on the other aspect of the question, for the matter requires careful consideration from both.

I have no desire to prove too much, as I certainly should appear to attempt to do were I to advocate the theory that Calcutta or any other part of the plains of India is a *desirable* locality for the training and nurture of European children; such, indeed, would be a theory as dangerous as false. For although the exceptionally favourable circumstances of the European Female Orphan Asylum prove that the European child may thrive, yet it is certain that without favouring influences it will not; and the statistics of infant life in the British Army in India, as I have also shown, prove not only that such is the case, but that the obstacles to success in the rearing of children are very great.

Moreover, the mere question of health up to a certain age, and the acquisition of knowledge, are not the only subjects requisite in the proper training of a child. It has long been known to the English in India that children may be kept in that country up to five, six, or seven years of age without any deterioration, physical or moral, and in the higher classes of life with probably as little, if not less, danger to life than in England; for most assuredly in some respects—as, for example, scarlatina, measles, hooping-cough, thoracic complaints, and even dentition,—they suffer less in India than in England. But after that age, unless a few hot seasons spent in the hills should enable parents to keep their children in India until a somewhat later age, to do so is always a doubtful proceeding. The child must be sent to England, or it will deteriorate physically and morally—physically, because it will grow up slight, weedy, and delicate, over-precocious it may be, and with a general constitutional feebleness not perhaps so easily defined as recognised, a something expressed not only in appearance, but in the very intonation of the voice; morally, because he learns from his surroundings much that is undesirable, and has a tendency to become deceitful and vain, indisposed to study, and to a great extent unfitted to do so,—in short, with a general tendency to deterioration, which is much to be deprecated, and can only be avoided by removal to the more bracing and healthy (moral and physical) atmosphere of Europe.

Now, for many reasons, I think the notion is correct—that it is right that European children born in India should be brought up in Europe. But, as I have before remarked, as it must so often happen that the parents are unable to meet the cost of doing this, it is satisfactory to know that the climate of the plains of India is not of necessity fatal, as I think the history of the European Female Orphan Asylum incontestably proves, whilst it suggests the reflection how much more might be effected. I have no doubt that all that can be done in Calcutta under peculiarly favourable circumstances could be, and is, done better in the hill stations, and I have seen European children who have been born and brought up in these localities, who in physical health were not inferior to those who had been reared in Europe; and of such no doubt the numbers will continue to increase, for, as I have said, the Europeans who are unable to send their children home are becoming more numerous. Such schools, I am happy to say, are already existing, and their numbers will probably

extend, and I have no doubt will be much appreciated,—for the hill stations of India promise to become a permanent home to many of the class of planters, landowners, and even retired commissioned and non-commissioned officers. Such stations, notwithstanding their excellent climate, are, I think, too few and far between and too isolated to become the seats of real colonization; and though they may and will be the home of many Europeans, I believe they will never be such in a permanent sense.

I feel certain also that Europeans residing in India who wish to do full justice to their children, will, although it involve separation for years, continue to send them to Europe even in preference to the hills. But it is satisfactory to know that, for those to whom this is impossible, their children can be reared in the hills; and to others still more hindered by the pressure of impecuniosity than even in Calcutta or the plains, their children may with care grow up and become fitted for life in India—at all events for one generation. I have seen the third generation of Europeans in Calcutta born and brought up there. Such are rare, but examples are not wanting. Though neither in physical nor mental properties was there anything to suggest marked degeneration, yet there is that which would make one look with great doubt on the prospects of a race so produced.

It is a fact that some of the life assurance offices charge 10 per cent. more on the life of a European born and brought up in the plains of India. They attach the same value in fact to his life as to that of the Eurasian. It would be difficult, perhaps, to justify this on statistical grounds, but it shows, at least, how strong the feeling on the subject is in India; and I cannot help saying that generally I think they are right.

I have endeavoured to show by what I have said that although the mortality among European children in India is, as a rule, very high, yet that under judicious management and proper hygienic conditions more favourable results may be obtained;—not that the European child can thrive and be reared as well as in the hill stations of India or in Europe, but that life and a very fair amount of health is possible even in Calcutta under *favourable circumstances*, and that as the numbers are increasing who must expect to bring up their children in India, they need not despair even though their lot be cast in Calcutta.

If anything I have said or could say had thrown a light on the subject, or would encourage those who have already done so much, and others who, with the power, are only wanting the opportunity of doing more in aiding in so good a cause as the protection of the child-life of their poorer fellow-countrymen whose lot has been cast in India, I should feel satisfied that this brief relation of my own experience on the subject has not been without result; and that it may stand as its own apology for these tedious details.

LONDON: PARDON AND SON, PRINTERS, PATERNOSTER ROW.

REMARKS

ON

THE PREVALENCE AND DISTRIBUTION

OF

FEVER IN DUBLIN.

Illustrated by a Map, Tables, and Diagrams;

WITH

APPENDICES ON SANITARY MATTERS IN THAT CITY.

BY

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1872.

PREFACE.

THE more important of the following remarks were brought forward as a paper before the Medical Association of the King and Queen's College of Physicians, and have appeared in abstract in the columns of several of the Medical Journals. It was my original intention to have published this paper *in extenso* in the pages of the *Dublin Quarterly Journal of Medical Science*, but at the request of many friends I have brought it forward in its present form, joining them in the hope that the publication of these details will tend to the sanitary improvement of Dublin.

T. W. G.

13, MOLESWORTH-STREET,
DECEMBER 10TH, 1871.

REMARKS ON FEVER IN DUBLIN.

In bringing forward the following remarks at the present time, I am performing an unpleasant duty—unpleasant, because I have to show not only that fever is more prevalent in Dublin than it had been during the past few years, and that it is on the increase, but that the form of fever, considered by sanitarians as the most preventible, is that most increased; that fever is widely spread through Dublin, and that the conditions which favour the spread and production of fever, and with it all forms of zymotic disease, are so rife in our city, that we cannot expect any permanent diminution in fever without some great change in our present sanitary system.*

It has been my intention for some time to arrange and map out certain information which I have been collecting with regard to the distribution of fever in Dublin, with especial reference to those cases admitted into Cork-street Fever Hospital. I did not intend to make these observations public until after the close of the Hospital year in March next; but certain circumstances have recently occurred which have induced me to hurry on these observations, and to add to them some remarks on the prevalence of fever in Dublin.

I do not wish again to refer to the paper war which raged during the autumn in the Dublin newspapers and *British Medical Journal*, in which I took a prominent part; yet I think I may state, that although it may have been attended with some disadvantage to all engaged in the discussion, the public are likely to derive some advantage therefrom, and have been incited to take an interest in

* See Appendix D.

the prevention of contagious disease. The occasion of the discussion I have referred to caused me to bring forward this paper at the present time.

I do not propose to enter upon the general question of the sanitary condition of Dublin.

This paper naturally divides itself into two parts; the prevalence of fever, and its distribution.

I shall first consider the question of the prevalence of fever in Dublin. If we look at the accompanying Table (No. 1), and Diagram (No. 1), we shall see the fluctuations in fever and zymotic disease in Dublin during the fifteen years ending March 31st of the current year. This table includes some other diseases not of the febrile zymotic class, but practically these make but little difference in the fluctuations. Fever is practically our zymotic disease, and all the fluctuations in the curves in the diagram may be considered as due to the increase or decrease of that disease.

The diagram shows the state of things better than the table.

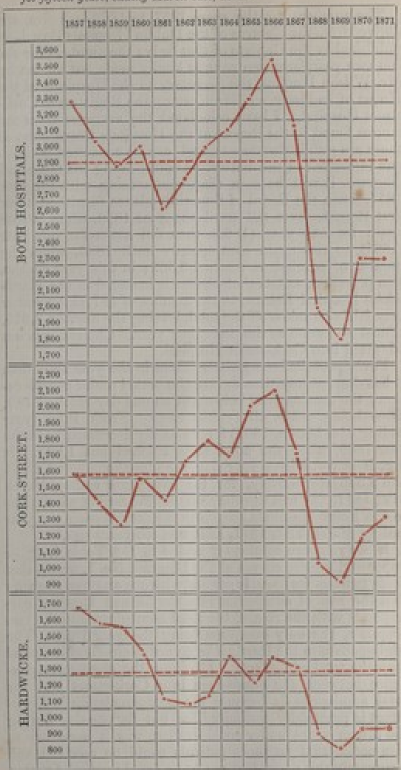
TABLE I.

Showing the Admissions into the Cork-street Fever Hospital, and the Hardwicke Fever Hospital, from the year ending March 31st, 1857, to March 31st, 1871.

Year ending	Admissions into Cork-street Hospital.	Admissions into Hardwicke Hospital.	Total Admissions.
(1)	(2)	(3)	(4)
March 31st, 1857	1,606	1,705	3,311
" 1858	1,466	1,626	3,092
" 1859	1,310	1,609	2,919
" 1860	1,616	1,430	3,046
" 1861	1,478	1,174	2,652
" 1862	1,700	1,129	2,829
" 1863	1,845	1,179	3,024
" 1864	1,747	1,405	3,152
" 1865	2,086	1,249	3,335
" 1866	2,151	1,411	3,562
" 1867	1,774	1,379	3,153
" 1868	1,098	931	2,029
" 1869	965	858	1,823
Total	20,842	17,085	37,927
Average ..	1,603	1,314	2,917
March 31st, 1870	1,270	994	2,264
" 1871	1,357	986	2,343

DIAGRAM I.

Showing the relations between the Admissions into Cork-street Hospital, the Hardwicke Hospital, and the Total Admissions into both Hospitals, for fifteen years, ending March 31st, 1871.



The numbers for the years 1857 to 1869 inclusive, are derived from the Returns of the Dublin Hospitals Board, as published in the Reports of that body; the numbers for the last two years are from returns kindly made out for me by Mr. Wilson Hughes, the Secretary to the Hospitals of the House of Industry, and Mr. Eustace, the Registrar of Cork-street Hospital. I have calculated the averages from the figures found in the Report of the Hospitals Board only, as these are public documents, and can be consulted by any-one interested in the matter. On inspecting the table and diagram, it will be seen that, commencing with the year 1857, when the Board of Superintendence furnished their first Report, fever fell until the year 1859, when it rose again for one year (1860), then fell again for one year (1861), to rise again continuously until 1866, when the number of admissions reached 3,562; in this year cholera also prevailed, and as that disease is included in the Hardwicke Hospital Returns to the number of 187, this number may fairly be taken off the total, leaving the number 3,375, almost the same as the preceding year. Cholera was not admitted into Cork-street Hospital.

Fever prevailed to a greater extent in the year 1866 than it has done at any time during the period under consideration; the numbers in Cork-street on one day reached 185, these being nearly all typhus cases. From 1866 (year ending 31st March, 1867) fever steadily decreased until the year 1869, when the admissions reached but 1,823. It has, however, been since rising, the admissions being 2,264 and 2,343 respectively, for the two years ending March 31st, 1871. It will thus be seen that the rate of admissions to the Fever Hospitals was much the same during the year ending March 31st, 1871, as it was ten years ago.

If we compare columns 2 and 4 in the Table 1, or the upper and middle curves of the Diagram No. 1, we see that these two run very nearly parallel with one another, showing that the rate of admissions into Cork-street Hospital corresponds with the rate of the total admissions into the two hospitals, the only exception being the year 1864. The admissions into the Hardwicke do not so closely correspond with the total admissions. I believe the close correspondence between the admissions into Cork-street and the total admissions is, because the accommodation in Cork-street is practically unlimited, as but for one day during the fifteen years under consideration, was it necessary to give notice that no more patients could be received, and fortunately this notice had not to be acted upon. Another

reason is, that as far as practicable, none but contagious febrile diseases are admitted into Cork-street. The close proximity of the Hospital to the most fever-stricken districts of course is an extra reason why the admission rate should so closely measure the prevalence of fever. From this account we see that fever, which had decreased, has been on the increase for the past two years. We may test this question again in another way, but not for so long a period, by consideration of the Death Returns of the Registrar-General, as published in the weekly slips, for Dublin. Table 2, and Diagram 2, show the number of admissions into Cork-street Hospital by quarters, for the five years ending September 30th, 1871, and the deaths from fever registered during the same period.

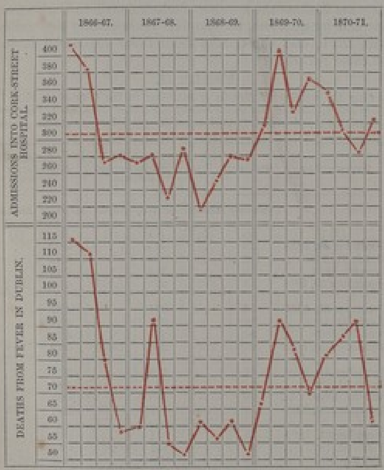
TABLE II.

Showing the number of Deaths from Fever in the City of Dublin, by quarters, for the two years ending September 30th, 1871, compared with the Admissions into Cork-street Hospital during the same period.

Quarter ending	Deaths from Fever.		Admissions into Cork-street Hospital.		Rate of Admissions to Deaths.	
	Quarterly	Annual.	Quarterly	Annual.	Quarterly	Annual.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
December 31, 1866	115	.	415	.	3·60	.
March 31, 1867 ..	112	.	382	.	3·41	.
June 30, 1867 ..	79	.	272	.	3·44	.
September 30, 1867	56	362	278	1,347	4·96	3·72
December 31, 1867	58	.	271	.	4·67	.
March 31, 1868 ..	92	.	277	.	3·01	.
June 30, 1868 ..	53	.	221	.	4·17	.
September 30, 1868	50	253	286	1,055	5·72	4·17
December 31, 1868	61	.	215	.	3·52	.
March 31, 1869 ..	56	.	243	.	4·33	.
June 30, 1869 ..	60	.	278	.	4·63	.
September 30, 1869	51	228	277	1,013	5·43	4·44
December 31, 1869	65	.	314	.	4·83	.
March 31, 1870 ..	91	.	401	.	4·40	.
June 30, 1870 ..	83	.	323	.	3·89	.
September 30, 1870	68	307	372	1,410	5·47	4·59
December 31, 1870	82	.	356	.	4·34	.
March 31, 1871 ..	85	.	306	.	3·60	.
June 30th, 1871 ..	92	.	281	.	3·05	.
September 30, 1871	61	320	321	1,264	5·26	3·95
Total ..	1,470	1,470	6,089	6,089	4·14	4·17
Average ..	73·5	292	304·45	1217·8	4·14	4·16

DIAGRAM II.

Showing the relations between the Admissions into Cork-street Hospital and the Death Rate from Fever in Dublin, for five years, ending September 30th, 1871.



I have divided the number of admissions by the number of deaths, and give the result in columns 6 and 7 of the table: of course, if the ratio were exact, which could hardly be expected, the result should always be the same. This, however, is not the case, but the correspondence appears to me to be surprisingly close. The relations between columns 2 and 4 of the quarterly deaths and admissions is better shown on Diagram 2.

If we compare the annual death-rates (column 3, Table 2) with one another, we find that for the past two years, fever, and deaths from fever, have increased to nearly what they were five years ago, and both are above the average of the five years under consideration. I have thus shown that fever has not been permanently checked in Dublin, but is in pretty much the same state that it was ten years ago, and is above the average of the last five years. I believe that the low fever-rate of the years 1868 and 1869 was but one of those temporary fluctuations which occur from time to time, and cannot be ascribed to action taken under the Sanitary Act of 1866, or if it can be ascribed to such action, then the measures taken must have been so relaxed that fever is resuming its old sway in Dublin.

I have next to consider the relative prevalence of late of the different forms of fever. In considering this question we may leave relapsing fever out of the question, as but two cases of that disease have been admitted into Cork-street Hospital during the past two years. Table 3 shows the admissions, by weeks, of typhus, enteric, and simple fever, during the two years ending September 30th, 1871, and the total admissions from the three kinds of fever. Table 4 shows the numbers of admissions for the same period, and for the same diseases, by months; and Diagram 3 shows the relations between the prevalence of the three forms of fever—typhus, enteric, and simple. In the diagrams, the dotted transverse lines represent the average prevalence of each form of fever. From this it will appear that while typhus and simple fever have been on the decrease, enteric fever has been on the increase; thus, in the year ending September 30th, 1870, typhus was above the average during eight months, while the following year it was above the average for but four months; on the contrary, enteric fever was but one month above the average

TABLE III.

Showing the Weekly Admissions into Cork-street Hospital of Typhus, Enteric, and Simple Fever, for two years, ending September 30th, 1871.

T. (Typhus). E. (Enteric). F. (Febricula).

Week ending	T.	E.	F.	Total	Week ending	T.	E.	F.	Total
Oct. 2, 1869	5	9	9	23	Oct. 8, 1870	4	.	19	23
,, 9 ,,	4	2	4	10	,, 15 ,,	9	3	11	23
,, 16 ,,	2	1	8	11	,, 22 ,,	10	3	3	16
,, 23 ,,	3	1	7	11	,, 29 ,,	10	6	19	35
,, 30 ,,	1	2	5	8	Nov. 5 ,,	7	6	12	25
Nov. 6 ,,	13	2	13	28	,, 12 ,,	7	1	8	16
,, 13 ,,	6	.	5	11	,, 19 ,,	5	1	14	20
,, 20 ,,	11	1	10	22	,, 26 ,,	15	6	13	34
,, 27 ,,	11	1	7	19	Dec. 3 ,,	7	3	8	18
Dec. 4 ,,	7	3	10	20	,, 10 ,,	8	2	10	20
,, 11 ,,	9	3	13	25	,, 17 ,,	3	1	15	19
,, 18 ,,	4	2	11	17	,, 24 ,,	11	.	9	20
,, 25 ,,	5	2	4	11	,, 31 ,,	6	2	17	25
Jan. 1, 1870	6	3	11	20	Jan. 7, 1871	11	2	11	24
,, 8 ,,	8	.	17	25	,, 14 ,,	12	3	18	33
,, 15 ,,	10	3	24	37	,, 21 ,,	15	4	11	30
,, 22 ,,	9	2	8	19	,, 28 ,,	5	1	9	15
,, 29 ,,	6	.	19	25	Feb. 4 ,,	4	3	19	26
Feb. 5 ,,	8	3	5	16	,, 11 ,,	9	6	11	26
,, 12 ,,	20	1	24	45	,, 18 ,,	6	1	11	18
,, 19 ,,	8	1	17	26	,, 25 ,,	2	1	6	9
,, 26 ,,	13	2	13	28	March 4 ,,	5	4	11	20
March 5 ,,	7	1	15	23	,, 11 ,,	2	1	9	12
,, 12 ,,	8	1	14	23	,, 18 ,,	.	2	5	7
,, 19 ,,	8	3	13	24	,, 25 ,,	2	3	16	21
,, 26 ,,	6	2	14	22	April 1 ,,	7	3	7	17
April 2 ,,	10	.	9	19	,, 8 ,,	7	2	12	21
,, 9 ,,	9	1	9	19	,, 15 ,,	5	3	10	18
,, 16 ,,	4	2	8	14	,, 22 ,,	8	3	7	18
,, 23 ,,	16	2	13	31	,, 29 ,,	1	3	11	15
,, 30 ,,	11	2	12	25	May 6 ,,	4	1	5	10
May 7 ,,	9	3	4	16	,, 13 ,,	8	1	5	14
,, 14 ,,	4	1	10	15	,, 20 ,,	8	2	9	19
,, 21 ,,	7	3	13	23	,, 27 ,,	2	2	5	9
,, 28 ,,	3	3	14	20	June 3 ,,	2	2	*10	14
June 4 ,,	6	3	16	25	,, 10 ,,	7	2	4	13
,, 11 ,,	8	.	8	16	,, 17 ,,	1	8	8	17
,, 18 ,,	7	1	9	17	,, 24 ,,	1	4	7	12
,, 25 ,,	4	1	8	13	July 1 ,,	2	5	4	11
July 2 ,,	4	1	2	7	,, 8 ,,	4	6	5	15
,, 9 ,,	8	2	14	24	,, 15 ,,	4	.	9	13
,, 16 ,,	5	2	8	15	,, 22 ,,	2	3	9	14
,, 23 ,,	12	2	16	30	,, 29 ,,	3	3	10	16
,, 30 ,,	3	1	12	16	Aug. 5 ,,	5	3	13	21
Aug. 6 ,,	7	2	20	29	,, 12 ,,	5	2	*14	21
,, 13 ,,	8	1	23	32	,, 19 ,,	2	1	10	13
,, 20 ,,	10	.	20	30	,, 26 ,,	2	3	9	14
,, 27 ,,	8	1	13	22	Sept. 2 ,,	9	6	11	26
Sept. 3 ,,	6	1	8	15	,, 9 ,,	4	8	6	18
,, 10 ,,	9	4	16	29	,, 16 ,,	2	5	4	11
,, 17 ,,	11	5	17	33	,, 23 ,,	2	4	7	13
,, 24 ,,	7	3	15	25	,, 30 ,,	.	7	12	19
Oct. 1 ,,	9	3	7	19					

* 1 Relapsing.

TABLE IV.

Showing the Monthly Admissions into Cork-street Hospital of Typhus, Enteric, and Simple Fever, for the two years ending September 30th, 1871.

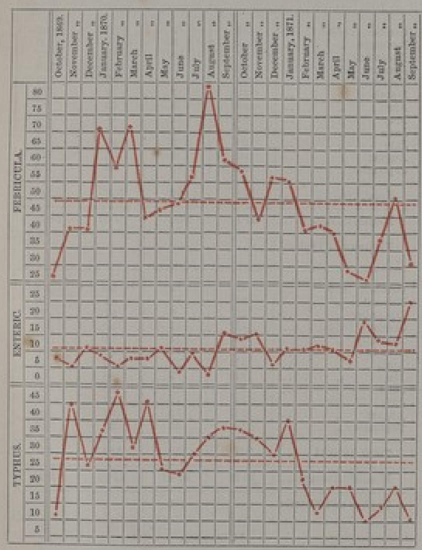
T. (Typhus). E. (Enteric). F. (Febricula).

Month.	Typhus.	Enteric.	Febricula.	Total.
October, 1869 ..	12	7	26	45
November ,, ..	44	5	41	90
December ,, ..	27	10	40	77
January, 1870 ..	37	9	72	118
February ,, ..	49	5	59	113
March ,, ..	31	7	72	110
April ,, ..	46	7	44	97
May ,, ..	25	11	47	83
June ,, ..	24	4	48	76
July ,, ..	30	9	57	96
August ,, ..	35	3	84	122
September ,, ..	38	15	62	115
Total, 1869-70 ..	398	92	652	1,142
Monthly Average ..	33·17	7·66	54·33	95·16
Typhus and Typhoid	..	490		
October, 1870 ..	37	14	58	109
November ,, ..	35	15	44	94
December ,, ..	30	6	57	93
January, 1871 ..	41	11	56	108
February ,, ..	23	11	41	75
March ,, ..	13	12	43	68
April ,, ..	21	11	40	72
May ,, ..	21	7	28	56
June ,, ..	11	19	25	*55
July ,, ..	14	14	37	65
August ,, ..	21	13	51	85
September ,, ..	10	25	32	67
Total, 1870-71 ..	277	158	512	947
Monthly Average ..	23·08	13·16	42·66	79·00
Typhus and Enteric	..	435		

* 1 Relapsing.

DIAGRAM III.

Showing the relations between the number of cases of Typhus, Enteric, and Febricula, admitted into Cork-street Hospital, during the two years ending September 30th, 1871.



in the first year, while in the second it was above the average for nine months. It is worth remark here, that the increase of the simple forms of fever generally accompany, or immediately precede, or follow increase in either of the other forms. When it is considered that enteric fever is now generally considered by sanitarians to be dependent on defective drainage or impure water supply, it is difficult to account for this sudden increase of that form of fever in Dublin, as we know that the water supply is nearly perfect, and that the drainage has been steadily though slowly improving. This increase of enteric fever is difficult to explain. It has been suggested to me that the stirring up of dirt, consequent on the construction of new drains, might be the cause; but I cannot see that this can account for it, as I find fever connected with local unsanitary conditions, and I have not, in any of the fever-nests I have visited, discovered that there has been any such local stirring up, for the very good reason that there has been no attempt at forming effectual drains for those houses. I do not believe that the Vartry water is the cause, as, if it were, the increase of enteric fever should have occurred before the present year. I admit, however, that I have heard of a suspicion of sewage pollution of the Roundwood reservoir. There is one way in which the Vartry water may have indirectly caused pollution of drinking water, namely, people not liking the Vartry have taken to an old pump, and I have found a considerable number of instances of this kind. I think, however, we must look to the peculiarities of the weather we have lately had, namely, dampness, as a cause; but here I am again puzzled, as I have found that an increase of moisture favours an increase of typhus, and shown this to be the case in a paper read before the Medical Association of the College of Physicians on January the 17th, 1866 ;* but this will not explain the production of enteric fever under similar circumstances. I believe myself that the conditions favourable to the production and spread of typhus and enteric fever are more closely allied than is generally supposed to be the case. I shall presently sho w that all forms of continued fever are frequently produced under identical circumstances. I must now proceed to the second part of my subject, namely, the distribution of fever in Dublin.

* See Dublin Quarterly Journal of Medical Science, vol. 41, p. 309.

TABLE V.

Showing the Distribution of Deaths from Fever between the North and South sides of the City of Dublin, for the five years ending September 30th, 1871, and their relation to the area and population.

—	North Side.	South Side.	Total.
Area in Statute Acres	1,868	1,940	3,808
Population in 1871	108,288	137,434	245,722
Population per Acre	57·9	70·8	64·25
Deaths from Fever, Year ending September 30th, 1867	140	213	362
" " 1868	93	160	253
" " 1869	82	146	228
" " 1870	110	197	307
" " 1871	120	206	326
Total	554	922	1,476
Average	110·8	184·2	295·2
Deaths per Population on five years	195·4	149·0	166·4
Average Deaths per Population for one year	977·3	746·1	832·4

If we look at Table 5 we shall see the distribution of fever in Dublin as shown by the Death Returns of the Registrar-General for the five years ending September 30th, 1871, from which it will be seen, that of the 1,476 deaths from fever during that period. 922 were on the south side of the city, and but 554, or about half the number, on the north side. This is not merely owing to the larger population of the south side than the north, for the ratio of deaths to the population on the south side of the city was 1 in 149·8, while it was but 1 in 177·5 on the north side, the annual average being 1 in 977·3 for the north, and 1 in 746·1 for the south side. This state of things is easily accounted for when we compare the population per acre on the north and south sides, it being but 57·9 per acre on the north, while it is 70·8 per acre on the

south side, and this gives but a faint idea of the density of the population in the fever districts; thus, in Woodquay Ward, which includes a considerable portion of the worst fever district, the population is 145 per acre, which we may compare with Fitzwilliam Ward (part of which merely touches on the fever district,) where the population is but 52 per acre. It thus appears that the great bulk of the fever of Dublin occurs on the south side of the city, and to this side I shall confine the rest of my remarks with regard to the details of the distribution of fever, and the localities from which the Cork-street Hospital patients are derived. This portion of the inquiry will consist of three parts; first, the districts where fever prevails; secondly, the streets which furnish the largest number of patients; and thirdly, the homes of the patients. With a view of making the inquiry as complete as possible, I have taken into consideration the streets which have furnished fever cases during the past ten years, but as it would be of little practical utility to show the exact locality where fever prevailed several years ago, I have only gone minutely into the inquiry for the last two years, ending September 30th, 1871. This inquiry embraces the south side of the city only, which I may call the Cork-street Hospital fever field, as the north side may be called the Hardwicke Hospital fever field. Some cases of fever pass from the south side to the Hardwicke Hospital, and some, perhaps a greater number, come from the north side to the Cork-street Hospital, but practically Cork-street gets all from the south, and the Hardwicke all from the north side of the city. Some allowance has also to be made for the cases admitted into Stevens', the Meath, Sir Patrick Dun's, the Adelaide, and City of Dublin Hospitals, which act as disturbing causes, each especially in its own locality, and of course impair the accuracy of some of the results as marked on the map, but will not, I think, affect materially my conclusions as to the distribution of fever on the south side of the city. This inquiry extends over two years, and embraces investigation into the circumstances connected with 1,825 cases of fever (including only simple, typhus, and enteric fevers) derived from 1,190 houses, and from 266 streets, lanes, courts, and alleys.

Although an inquiry into the distribution of scarlatina, small-pox, and other forms of contagious febrile diseases would be of great interest, yet as these diseases are less within the control of sanitary measures (small-pox excepted) than the continued fevers, and as it would tend to complicate the present inquiry, I have excluded them from consideration in this paper, and confined my attention to the continued fevers only.

If we look at the accompanying map,* we see that a number of red dots are scattered over its surface; these mark the position of the houses from which fever cases were derived, and admitted into Cork-street Hospital during the ten years ending September 30th, 1871. Some streets are marked by dotted red lines; this indicates streets which furnished a large number of cases of fever, but where, for various reasons, the houses could not be accurately defined. I have not marked any streets which had not been fever streets during the past ten years. I should here mention some difficulties I have met with in my inquiries; some were insurmountable, and therefore lead to inaccuracies in the map; there were—first, bad description of locality by the patient, owing to several streets bearing the same name, as the Kevin-streets, Hanover-streets, Essex-streets, &c., and owing to the ignorance of the patient as to the number of the house; secondly, bad numbering of houses; many houses having no numbers, others having numbers put on in chalk by the inhabitants, quite regardless of the position in the street; thus I have found 54 next door to 33. I have succeeded in correcting some of these mistakes, but I have often had to give up the attempt to mark the houses, and in some instances have found the confusion so great, that I have had to leave whole streets without marking any houses in them. In many instances I have found, when visiting streets with a view of correcting mistakes, that it was quite impossible to find where a patient came from. Again, houses have been divided into two or three, and others joined together, and corner houses are often complete complications of numbers. Another, though not serious difficulty, I had to contend against, was the unwillingness of the inhabitants (chiefly through fear of their landlords) to give information; but, as a rule, I met with civility mixed with a considerable amount of distrust as to my intentions.

On looking at the marked portions of the map, any one

* This map has been constructed from a large ordnance map, upon which each fever house was individually marked.

MAP SHOWING THE DISTRIBUTION OF FEVER ON THE SOUTH SIDE OF THE CITY OF DUBLIN FOR THE TWO YEARS ENDING SEPTEMBER 30TH, 1871.

Houses furnishing Fever cases during two years ending September 30th, 1871

Fever streets in which the houses could not be accurately defined

Boundary of Fever districts

well acquainted with the south side of the city of Dublin will at once see that these fever streets are naturally distributed among three districts, and these districts are not only naturally divided by the lie of the city, but also by the nature and age of the streets and houses contained therein, and what is more important for our present purpose, by the prevalence of fever in each.

The north side of the city may be divided into four districts by two lines of streets. It is divided into north and south by a line (dotted black on the map) from west to east, running along from Kilmainham by Mount Brown, James's-street, Thomas-street, Corn-market, High-street, Christchurch-place, Castle-street, Cork-hill, Dame-street, College-green, Nassau-street, Leinster-street, Clare-street, Merrion-square north, and Lower Mount-street It is divided into east and west by a line drawn north and south down Westmoreland-street, College-green, Grafton-street, Stephen's-green west, Harcourt-street, and Charlemont-street. We have thus four districts, north-east, north-west, south-east, and south-west. Of these, three are fever districts, the north-east, north-west, and south-west; the fourth, the south-east, may be said to be free from fever, except a small portion south of Lower Mount-street, which might fairly be included in the north-east division. For my present purpose I shall name three districts, as follows:—first, Coombe valley (south-west division); second, West River (north-west division); third, East River, (north-east division). I have numbered those in accordance with the prevalence of fever in each; the first furnishing by far the larger number of cases. Besides these, there are certain places outside the south city from which a considerable number of cases are derived; these are Clondalkin, Golden Bridge, Chapelizod, the district around Church-street, and Sandymount. There are also several public institutions which sent cases to Cork-street Hospital; these were St. Vincent's, Jervis-street, Lock, and Coombe Hospitals, and the Royal Hospital. The Night Asylum furnished 55 cases, most of them febricula. Besides those that arose in the hospital itself, among the nurses and ward-maids, 9 cases of typhus, 8 of simple, and four of enteric fever; of these, but one proved fatal.

I have already defined the extent of the three fever districts, but I wish more particularly to refer to the nature of these districts. The Coombe valley presents many peculiar features which tend to make it particularly unhealthy; it is a hollow, bounded on the north by the hill, upon the ridge of which are situated James's-street, Thomas-street, and as far as Cork-hill; bounded on the south by the hill, upon the ridge of which Newmarket stands, it slopes gradually upwards towards Stephen's-green on the east, and to Dolphin's-barn on the west. A sort of branch of this valley is occupied by New-row (by the Poddle), Black Pitts, New-street, and Clanbrassil-street, sloping towards the South Circular-road. This valley is very low at its lowest part, near St. Patrick's Cathedral, where the elevation is but 40 feet above the low water of spring tide, as marked on the ordnance map, being a fall of 20 feet from the Thomas-street line, which is 60 feet above the same level, to the lower end of the Coombe and Deane-street. The outlet of the Coombe valley towards the river is by Ross-lane, Bride-street, and Ship-street, through the Castle. The Poddle and its branches wind in this valley, and from the lowness of the situation it is evident that there are considerable difficulties in the way of drainage; but it is not undrainable, and I believe the district is pretty well provided with main drains, with a good fall in the larger streets, but in the majority of courts and alleys there is no drainage properly so called. The map shows at once that all the streets sloping into this valley, and those occupying its lower parts, are well-marked fever streets, and the red dots are more numerous and more closely set than in any other part of the city; not only is this district the worst situated, but it contains the greatest number of narrow courts, lanes, and alleys (densely populated), old houses, manure yards, cat-gut, glue, size, and other similar manufactories, and besides these, perhaps the most dangerous nuisance of all is the number of dairy yards.

The West River District has much greater facilities for drainage, and fewer nuisances than the Coombe valley, and we see accordingly the red dots are less numerous and more scattered.

The East River District is lower lying, and therefore less easily drained than the West River, but has the advantages of being more open to sea breezes, and fewer nuisances; for although the vitriol works are objected to by some, yet I think these must be considered as rather wholesome than injurious, as they are constantly diffusing

disinfectants through the neighbouring atmosphere. So much for the districts. Next I shall consider the distribution of fever through these districts. I have divided the houses furnishing fever cases into three classes, namely—first, those furnishing 5 or more cases each during the two years ending September 30th, 1871; second, those furnishing 3 or 4 cases; and third, those furnishing 1 or 2 cases only. Tables 6 and 7 give lists of the two first classes of houses, with the number of cases, and nature of fever furnished by each of the houses. The cases, streets, and houses are distributed among the three districts, as shown in Table 8.

TABLE VI.

Houses furnishing five or more cases of Fever to Cork-street Hospital during the two years ending September 30th, 1871. Total, 41 houses.

Street and House.	Simple.	Typhus.	Enteric.	Total.	Street and House.	Simple.	Typhus.	Enteric.	Total.
9, Arthur's-lane ..	5	.	.	5	5, Hanover-st., East	2	4	.	6
32, Back-lane ..	.	8	1	9	18, Harmony-row	2	5	.	7
3, Bride-street ..	4	1	.	5	2, John-street ..	1	9	1	11
77 " ..	5	3	.	8	16, M'Guiness's-pl.	2	7	1	10
33, Bridgefoot-st.	1	3	2	6	17 " ..	2	9	.	11
58 " ..	*5	1	10	16	9, Marrowbone-lane	1	4	.	5
64 " ..	3	1	1	5	24, Meath-street ..	4	2	.	6
48 " ..	1	.	4	5	5, Michael's-square	1	4	.	5
22, Brown-street ..	5	1	.	6	4, Mullinahack ..	1	3	1	5
20, Castle-street ..	.	4	1	5	1, Mullinahack-lne.	1	3	1	5
36, Chancery-lane	.	7	1	8	54New-row(Poddle)	2	3	1	6
13, Clarence-place	2	5	.	7	5, Nicholas-street	5	3	2	10
18, Coombe ..	2	2	1	5	22, Patrick-street	2	3	1	6
10, Cork-street ..	2	2	1	5	40 " ..	4	1	1	6
2, Derby-square ..	1	4	1	6	9, Plunket-street ..	5	1	.	6
9, Essex-street ..	.	3	2	5	20 " ..	2	.	3	5
1, Fishamble-street	5	1	.	6	40 " ..	6	.	2	8
10, Francis-street	3	4	.	7	4, Portobello ..	6	.	.	6
16 " ..	4	.	1	5	15, Ross-lane ..	3	1	2	6
3, Gill's-square ..	3	3	.	6	14, Ship-street ..	2	3	.	5
21, Golden-lane ..	2	3	.	5	Total ..	...	...	...	270

* 1 Relapsing.

TABLE VII.

Houses furnishing three or four cases of Fever to Cork-street Hospital during the two years ending 30th September, 1871. Total, 81 houses.

Street and House.	Simple.	Typhus.	Enteric.	Total.	Street and House.	Simple.	Typhus.	Enteric.	Total.
18, Ardee-street ..	2	.	1	3	9, Hackett's-court	.	4	.	4
6, Arthur's-lane ..	2	1	.	3	26, Hanbury-lane	.	1	3	4
24, Back-lane ..	2	1	.	3	7, Hanover-lane ..	2	1	1	4
20, Bride-street ..	1	2	.	3	28 ,, ..	1	.	2	3
40 ,, ..	3	.	.	3	97, James's-street	1	3	.	4
9, Bridgefoot-street	4	.	.	4	4, Kennedy's-lane	3	.	.	3
7, Brown-street ..	4	.	.	4	23, Kevin-street ..	1	2	.	3
20 ,, ..	3	.	.	3	60 ,, ..	1	.	2	3
2, Castle-street ..	2	2	.	4	2, Mark's-alley ..	2	1	.	3
18, Chancery-lane	2	1	.	3	4, Meath-street ..	3	.	.	3
22, City-quay ..	2	1	.	3	10 ,, ..	3	.	.	3
25, Clarence-place	1	2	1	4	14 ,, ..	3	.	1	4
6, Cole-alley ..	2	2	.	4	15 ,, ..	3	.	.	3
12 ,, ..	.	3	.	3	20 ,, ..	4	.	.	4
24, Coombe ..	.	4	.	4	21 ,, ..	2	2	.	4
42 ,, ..	1	2	.	3	22 ,, ..	3	.	.	3
56 ,, ..	3	.	1	4	38 ,, ..	2	1	.	3
73 ,, ..	2	.	1	3	40 ,, ..	3	.	.	3
19, Creighton-street	1	1	1	3	49 ,, ..	1	2	.	3
17, Cuffe-street ..	2	.	1	3	2, Merrion Market	1	2	1	4
31 ,, ..	.	3	.	3	4, Michael's-lane ..	2	1	.	3
44 ,, ..	1	1	1	3	2, Monk's-court ..	2	1	.	3
50 ,, ..	.	4	.	4	47, New-street ..	4	.	.	4
4, Derby-square ..	3	1	.	4	65 ,, ..	1	2	.	3
3, Edge's-court ..	2	.	2	4	16, Pimlico ..	2	1	.	3
27, Elbow-lane ..	2	2	.	4	21, Plunket-street	3	.	.	3
25 Essex-street ..	3	.	.	3	38 ,, ..	3	.	.	3
4, Francis-street ..	3	.	.	3	39 ,, ..	1	.	2	3
44 ,, ..	3	.	.	3	17, Portland-street	3	.	.	3
77 ,, ..	2	1	.	3	13, Queen's-terrace	2	1	.	3
80 ,, ..	2	.	1	3	41, Thomas-street	3	1	.	4
82 ,, ..	2	.	1	3	147 ,, ..	2	1	.	3
84 ,, ..	4	.	.	4	3, Walker's-alley ..	2	1	.	3
1, Garden-lane ..	1	2	.	3	20, Watling-street	1	2	.	3
2, Gill's-square ..	1	1	1	3	19, Wood-street ..	3	1	.	4
9, South Gloster-st.	1	2	.	3	44, York-street ..	2	2	.	4
2, Golden-lane ..	2	1	.	3					
15 ,, ..	3	1	.	4	Total				247

TABLE VIII.

Showing the Distribution of cases of Fever Streets, and Fever Houses among the three Fever Districts, for the two years ending September 30th, 1871.

———	Coombe Valley.	West River.	East River.
Cases	1,172	189	164
Houses	753	124	108
Streets	156	41	42
Fever Houses per Fever Street ..	4·83	3·01	2·57
Patients per House	1·54	1·52	1·52
Houses furnishing five or more cases	26	11	4
Houses furnishing three or four cases	65	8	8
Total bad Fever Houses	91	19	12
Per-centage of Houses furnishing five or more cases	3·43	8·87	3·70
Per-centage of Houses furnishing three or four cases	12·07	15·32	11·11

From this table it appears that the bulk of the fever cases are furnished from the Coombe valley district. That while the average proportion of fever cases to each fever house is pretty much the same in each district, the proportion of fever houses per street is much greater in the Coombe valley than in the other districts, being 5 per street against 3 and $2\frac{3}{4}$ in the West and East River Districts respectively, showing that the fever houses are more closely set together in the former than in the two latter districts; the proportion of bad fever-nests to fever houses generally is less in the Coombe valley than in the West River district, and about equal to that in the East River; and this is also true of houses furnishing three or four cases, thus showing that the cases are more concentrated in individual houses in the two latter than in the former district; in fact, fever is more equally and closely distributed over the Coombe valley than the other districts. The map demonstrates the truth of these statements more clearly than Table 8, or any description.

We have next to consider the streets, lanes, alleys, and courts from whence the fever cases come. The streets are generally characterised by being composed of old—many of them once fashionable—houses, with bad rears, or no rears at all. It is not essential, as many suppose, that fever streets should be narrow and tortuous; on the contrary, two of the worst fever streets, Meath-street (the very worst), and Francis-street, are wide and straight. It is the age and condition of houses, and proximity of narrow courts and alleys, that especially characterise these streets, together with the want of proper house drainage, ash-pit, and privy accommodation for the houses themselves. As examples of the worst fever streets, I may mention Meath-street, with its 95 houses, 36, or more than a third, of which furnished in all 73 cases of fever to Cork-street Hospital during the two years; it contains one fever-nest furnishing 6 cases, and 10 others furnishing 3 or 4 cases each. Francis-street, with 140 houses, has 28 fever houses, furnishing 55 cases, has in it two fever-nests furnishing more than 5 cases, and 6 houses furnishing 3 or 4 cases each. The Coombe contains 129 houses, has 46 fever houses, furnishing 78 cases, one house furnishing 5 cases, and 4 others furnishing 3 or 4 cases each. These are sufficiently detailed examples of fever streets; but I could mention many others nearly, though not quite so bad. The lanes and alleys are probably worse than the streets, but must be merely looked upon as streets on a smaller scale. The courts (comprising yards and squares) are next to be considered. These are, perhaps, the most prolific fever beds, as few of them have failed to produce fever cases during the past two years. Fever streets are generally skirted by these courts, notably those which I have already given as special examples of fever streets There are several kinds of courts—first, those originally constructed as such; secondly, lanes closed up at one or both ends, and entered by archways; and thirdly, back yards and gardens that have, by the cupidity of the owners, been built upon, and the out-offices converted into dwelling-houses, thus crowding together a large number of small tenements in a very confined space. These latter are generally known by the name of yards, and are usually designated by the number of the house behind which they are situated. Few people besides clergymen and medical men are acquainted with the existence of these places.

Examples of the first form of court may be found in abundance off South Great George's-street and Kevin-street, and a considerable number in the neighbourhood of Townsend-street. They are, in fact, narrow, blind lanes, and have usually an open sewer running down the centre through the whole length, and emptying itself into the adjoining street, or into a trap near the entrance of the

court. These traps are frequently choked, and large quantities of sewage accumulate. There is usually a privy, seldom more than one, situated in each of these, as also in the other form of courts; the drainage from this privy, of course, finds its way down the open sewer already described in the centre of the court. The square may be considered as the last of these forms of court, samples of which are Gill's-square, off Cole-alley, Neil's-court, off Marrowbone-lane, Derby square, off Nicholas-street, &c. These squares have usually no drainage, and are surrounded by miserable old overcrowded houses, and are generally strewn with rubbish and filth, consisting, to a great extent, of human ordure, and have one or two cess-pools near the centre. I have already indicated the nature of the yards, several of which may be found in Marrowbone-lane, Cork-street, and the Coombe. The houses in all these are of the most filthy character, and the front house or houses in the street usually indicate the nature of what is behind, having the usual characters of a fever-nest, which I shall presently refer to more particularly. The ground of all these courts is saturated with decomposing organic matter, chiefly human excrement.

I have already pointed out that the houses from which fever cases have been derived number 1,190, with a few more added since my list was made out, in round numbers 1,200; these houses furnished 1,825 cases, with some additional cases not included in the classified list, making in all 2,000 cases. Of these infected houses, 41 furnished 5 or more cases each; the nature of the cases furnished by each are given in Table 6. Again, 81 houses furnished 3 or 4 cases, which are particularized in Table 7; the remainder of the houses furnished but 1 or 2 cases each.

The analysis of these tables give the following result:—

53	houses	furnished	3	cases each.
28	"	"	4	"
16	"	"	5	"
12	"	"	6	"
2	"	"	7	"
3	"	"	8	"
1	"	"	9	"
2	"	"	10	"
2	"	"	11	"
1	"	"	17	"
2	"	"	doubtful.	
122				

The total number of cases furnished by these 122 houses was 534, or more than a fourth of the whole number, showing how prolific these fever-nests are, and how much they endanger the health of the community, which is particularly suggested by 48 of these houses having fever next door to them.

The kind of fever furnished by these houses is an interesting question. Of the houses furnishing 5 or more cases—

13	Houses	furnished	cases	of three kinds of fever
19	,,	,,	,,	febricula and typhus
4	,,	,,	,,	febricula and enteric
4	,,	,,	,,	typhus and enteric
2	,,	,,	,,	simple only
0	,,	,,	,,	typhus only
0	,,	,,	,,	enteric only

showing that the most infected houses, as a rule, furnished more than one form of continued fever, proving that any one case of fever occurring in a house should at once direct the attention of the sanitary authorities to that house, with a view of arresting its spread, and the probable production of all kinds of fever. It is far from improbable that many of these houses which have furnished but one or two cases of fever are just commencing their career as fever-nests. I may mention that several of these fever-nests have also produced small-pox, scarlatina, measles, and cholera; of the last, I may mention the notorious house, 22, City-quay, where cholera first made its appearance in 1866.*

What are the characters of a fever-nest? The best way to answer this question is by describing one or two. I shall begin with the worst on my list, 58, Bridgefoot-street, now celebrated as a fever-nest, defying the sanitary autho-

* Of the condition of these houses I may also state that a large number are condemned houses, that is, houses declared by the authorities as unfit for human habitation; but through some evasion, or in many cases, in open violation of the law, these houses are still inhabited, and frequently the occupiers even pay rent. I find among my list of fever houses, there are 52 returned as bankrupt in the last report of the Collector-General of Rates; thus, the owners of these, which defy the tax-gatherer, and the condemned houses go free of the burdens of ordinary citizens, and claim as their privilege to spread disease and death at the expense of their honest, and, perhaps, not more prosperous neighbours. I regret to find that 45 fever houses stand upon the Corporation estates; many of these are let on long leases, and are out of the control of the landlords, and are an expensive legacy of our ancestors; but, unfortunately, there are other instances where, from the shortness of the lease, the landlords have a right to preserve their property from destruction, and ought to do so.

rities. This house is entered from the street by a passage, with a black and rotten floor, in which are open chinks communicating with the cellar below; the boards are damp, and sodden with dirt; going upwards we find things somewhat better, but the whole upper part of the house is dilapidated; going downwards, we first come to the entrance of a small back yard, a place covered ankle-deep with human filth, a privy and ash-pit totally unapproachable without passing through a sea of dirt, a water-tap running, and washing such of the dirt as is within reach into a pipe sewer which runs through the cellar of the house, and which had a hole through which the sewage passed into the cellar, converting it into a cesspool; this cellar was immediately beneath two rooms inhabited by a family of 15, every one of whom had enteric fever. In the same street I find another house with all these characteristics repeated, except the broken sewer, but this house had no sewer at all. A house in Chancery-lane which furnished 8 cases of fever (7 typhus and 1 enteric). I was met on entry by a horrible stench, proceeding partly from a filthy back yard, and partly from a slaughter house at the rere of a neighbouring house in Bride-street. The cellar of this house had been filled up; a very proper measure, if rightly carried out, but the filling up matters consisted of such material as to convert the cellar into a decomposing manure heap. The passage, back yard, and upper part of the house were similar to those already described at 58, Bridgefoot-street. I find similar conditions, varying only in degree, in almost every fever-nest. The less prolific fever-nests I find with less accumulated dirt, and notably less wet dirt. In many places where there was comparatively little dirt, what did exist was made do the maximum amount of damage by being kept in a continual state of moisture for want of proper drainage, or from drainage water from the roof or elsewhere running into the house by the doors, or through imperfectly closed cellar openings. These damp cellars, often nearly filled with rubbish, are to be found in all fever streets, and most fever houses. Many houses have no receptacle for rubbish except the cellars; this is particularly true of corner houses and houses near corners, many of which, if not public houses, are fever-nests.

We have next to consider the remedies for this state of things: these may be easily summed up in three words—

cleansing, draining, and clearing away. I believe the only cure for many of these places is a complete clearance of the ground. I consider all closed courts should be abolished, either by opening up to the main streets, or by complete clearance of the houses themselves. Perfect house drainage should be insisted on, all cellars should be filled up with dry and mineral materials, all privies and ash-pits should be cleansed by the authorities, not left to be done by the owners, who won't, or the occupiers, who can't do it.* The person receiving the rent from the occupier should be made responsible for the proper sanitary conditions of the houses; no excuse should be taken about the existence of another landlord; all tenement houses should be regularly inspected,† not by policemen, whose fellow-policemen often own or farm these houses, or collect the rents, but under the immediate direction of proper and well qualified health officers, and no better could be found than the dispensary medical officers.‡ Houses where fever has once occurred should be constantly watched, and reported upon; street lists of infected houses should be kept, such as I made when I undertook this inquiry.

But it must always be remembered that it is too late to commence sanitary work when fever has broken out. The houses should be maintained in proper sanitary condition. These preventive measures seem to me to have been altogether neglected in Dublin; no proper sanitary organization seems to exist; there is but one health officer, and he is badly paid; the sanitary inspectors are policemen, who go to inspect the houses of their friends, and the reports of infected houses by the hospital and dispensary medical officers are systematically ignored until they are sent to the newspapers; but as these are matters of public notoriety, which have gone on for months without any public contradiction, I shall not further refer to them in this place, but appeal to my professional brethren to use their influence with the public to compel the authorities to do their duty, and prevent the spread of contagious disease in our city.

* See Appendix C. † See Appendix A. ‡ See Appendix D.

APPENDICES.

APPENDIX A.

Since the foregoing was written, it has been proved by a letter from Mr. John Norwood, which appeared in *Saunders's News-Letter* of the 28th of October, that the duty of tenement inspection is so badly attended to, that, practically, it is not performed at all. *Saunders's News-Letter*, remarking upon Mr. Norwood's letter, says:—

"There being 9,300 tenement houses, there was but 16,484 inspections of them during five years, or less than two per house, during that period. They were at the rate of 3,296 per annum, or about one-third of those houses are inspected annually. The inspection of rooms amounts to 365,570 (73,114 per annum), or about 200 per day. Now, we do not see how four sanitary sergeants could efficiently inspect 200 rooms per day, and discharge their other duties."

I believe that at least a quarterly inspection of tenement houses is absolutely necessary, in order to maintain them in proper sanitary condition. It is not when a house has become a hot-bed of disease that inspection should commence, as seems too often to be the case.

Again, *Saunders's*, when referring to the account of the disinfecting of houses contained in Mr. Norwood's letter, remarks:—

"The disinfecting is as bad, for Mr. Norwood tells us, that of 6,287 infected houses reported, but 179 were disinfected, or 1 in 35. Thus, disinfecting of houses is carried on at the rate of 35 per annum, whereas we know there are generally between two and three thousand admissions to fever hospitals for every year, which must represent many hundreds of infected houses."

APPENDIX B.

"13, Molesworth-street, Dublin,
"*October 2nd*, 1871.

"Dear Sir,—As I wish to do all I can to promote sanitary improvement in Dublin, and as I see that the Public Health Committee of the Corporation have undertaken in earnest the rooting out of fever-nests (I here referred to the efforts being made to close a house, 58, Bridgefoot-street, which I had called special attention to in the newspapers—T. W. G.), I beg to inform you, that I have at present at my disposal a large amount of information relative to the distribution of fever on the south side of the city, all of which I shall be happy to make available as a means of assisting the Public Health Committee in their endeavours. This information I am arranging for other purposes, but should be sorry that any of it which may be of public advantage should not be utilized as soon as possible. I have thus information relative to the distribution of 1,825 fever cases admitted into Cork-street Hospital during the past two years; these came from 1,190 houses, contained in 266 streets, lanes, and alleys. I have visited a great number of these houses. I have made out 41 notable fever-nests, which have, during the past two years, furnished 5 or more cases each to the Hospital, and 81 other houses furnishing 3 or 4 cases. I beg to enclose a list of the 41 notable fever-nests. There may be some slight error in this list, but I believe it is nearly correct. Any information or advice I can give, I place heartily at the disposal of the Health Committee, and trust that it may be taken by them in as good part as it is offered. You will kindly lay this letter and enclosure before the Committee, and oblige

"Yours truly,

"T. W. GRIMSHAW.

"To the Secretary,
"Health Committee,
"City Hall."

"Corporation of Dublin.

"Public Health Committee,
"*City Hall, Dublin, 3rd October*, 1871.

"Dear Sir,—I beg to acknowledge the receipt of your note of yesterday, and the list of fever localities which you have been so good as to transmit.

"I shall lay these documents before the Public Health Committee, at their next Meeting—meantime I beg to say that I shall thankfully receive, and act on any information with which you may be kind enough to furnish me. Such contributions aid the Committee, for it is impossible for any sanitary staff to discover, amid such a population, more than a portion of what requires their intervention.

"Yours truly,

"JAMES BOYLE.

"T. W. Grimshaw, Esq., M.D."

"13, Molesworth-street, Dublin,
"*October 5th*, 1871.

"Dear Sir,—I beg to acknowledge the receipt of your letter of the 3rd instant, and to enclose a list of 81 more fever-nests less remarkable than those on the former list. I have also a street list of all the houses furnishing cases to Cork-street Hospital during the last two years. I shall be happy to let you have a copy of this list, but could not at present undertake to copy it myself.

"Yours truly,

"THOS. W. GRIMSHAW.

"The Secretary
"Public Health Committee,
"City Hall."

"Corporation of Dublin.
"Public Health Committee,
"*City Hall Dublin, 9th October*, 1871.

"Dear Sir,—Having submitted your letters of the 2nd and 5th inst., and the lists of "fever-nests" with which you were so good as to accompany them, to the Public Health Committee, at their meeting on the 6th, I am directed to transmit the subjoined Resolution which was then adopted in reference to the subject, viz.:—

"'Resolved, that the Secretary be directed to thankfully acknowledge the information conveyed in the letter of Dr. Grimshaw, and to inform him, that most, if not all, had been previously within the knowledge of the Committee, and proceedings taken in relation thereto; but that, up to the present, the Committee have not had the full assistance of the officials of the Cork-street Hospital, which has been so cheerfully given by the officials of the other Dublin Hospitals; and the Committee are glad to learn that there is a prospect of a different course of action on the part of the officials of the Cork-street Hospital for the future, as evidenced by Dr. Grimshaw's satisfactory communications.'

"Yours very truly,
"JAMES BOYLE, *Sec.*

"Thomas W. Grimshaw, Esq., M.D.,
"13, Molesworth-street."

"13, Molesworth-street,
"*October 14th*, 1871.

"Dear Sir,—I beg to acknowledge the receipt of your letter of the 9th instant, and enclosed Resolution of the Public Health Committee for which I am much obliged. In reply, I beg to inform you that I was quite aware that the Committee were previously in possession of the information I forwarded, as I know that that information had been from time to time supplied to the Committee by the Registrar of Cork-street Hospital. I merely offered it to the Committee, having had occasion to arrange it in a convenient form, and having ascertained that the Committee, in many instances, had neglected to make use of the information received. I wish it to be understood that the information sent by me was not offered in my official capacity as Physician to Cork-street Hospital.

"Yours truly,

"To the Secretary,
"Public Health Committee."

"THOS. W. GRIMSHAW.

From the foregoing correspondence it will appear—

1st. That I have done my best to aid the Health Committee, but that my aid was practically refused, by informing me that the Committee had already the information I offered.

2ndly. That while stating they are in possession of information, which could only have been obtained through the authorities of Cork-street Hospital, they charge those authorities with not supplying information.

I may here state that the authorities of Cork-street Hospital have, at all times, supplied all available information to the Health Committee whenever asked to do so.

3rdly. The statement in the resolution of the Committee of October 6th, 1871, that "Proceedings had been taken," in relation to this matter of fever-nests is, to say the least, dubious, and conveys a false impression, as no *apparent* proceedings had been taken, as shown by the numerous instances noticed by the public press. Up to the time of writing my letter of the 2nd of October, I had not found a single instance of any fever-nest which had been properly attended to.

APPENDIX C.

An almost abortive attempt has recently been made at a general cleansing of ashpits, by issuing the following notice —

"CORPORATION OF DUBLIN.

"NOTICE (29 and 30 Vic., cap. 90), for Periodical Removal of Manure, or other Refuse Matter.

"TO ALL WHOM IT MAY CONCERN.

"The Right Honorable the Lord Mayor, aldermen, and burgesses, acting by the Town Council, being the nuisance authority in the city of Dublin, hereby give notice and a public announcement that, within the city of Dublin henceforth from this date, they require that all ashpits and privies of houses occupied by members of more than one family, be emptied, cleansed, purified, deodorized, and disinfected regularly and periodically once in each month, viz.:—on or before the last day of each month.

"And also that they require the owners or occupiers of premises, upon or immediately before complying with the above, to thoroughly disinfect and deodorize the refuse matter contained in said privies and ashpits, so that it shall not be a nuisance, or injurious to the inhabitants of the said city.

"And in cases where it shall be necessary to permit the said refuse matter, so deodorized or disinfected, to remain upon the surface of any yard or other place, for the purpose of having the same removed or carted away, the said nuisance authority hereby give notice, that they require such refuse matter to be removed beyond the boundary of this city from such yard or place within the space of one hour from the time of the emptying of said privies and ashpits, or of the leaving of such refuse matter upon the surface of such yard or place.

"And the said nuisance authority hereby further publicly announce that they require all manure or other refuse matter to be in like manner deodorized, disinfected, and removed from mews, stables, slaughter-houses, and other like premises, every day before the hour of seven o'clock, a.m.

"And the said nuisance authority hereby give notice that if any of the terms of this public announcement be disobeyed or disregarded, immediate proceedings will be taken against the parties in default without further notice, for the purpose of enforcing the penalties provided by the statute.

"Signed by Order, H. MACLEAN, J.P.,
"Chairman of the said Nuisance Authority.

"J. BOYLE, C.E.,
"Secretary to the said Nuisance Authority.

"This 1st day of September, 1871."

This notice has, I know, been disregarded in hundreds of instances. In fact, it cannot be carried out, as up to the present there not having been a demand for such work, there is no adequate measure for the removal of house refuse. The cleansing of ashpits, &c., should be undertaken altogether by the municipal authorities, the inhabitants being bound to give notice in each instance where such cleansing is required. This system is very efficiently carried out in Glasgow and some other large towns.

APPENDIX D.

A PROPOSAL FOR THE IMPROVEMENT OF SANITARY ORGANIZATION IN DUBLIN.

The present Sanitary organization of Dublin seems to consist of—

1. A Sanitary Committee.
2. A Secretary to the Sanitary Committee.
3. A Medical Officer of Health.
4. A City Analyst.
5. Four Sanitary Sergeants.

From what has recently appeared in the public journals, it appears that this organization (if it deserves the name), has completely broken down, as the following specific charges have been brought against the persons responsible for the proper sanitary condition of the city.

1st. The scavenging of the city is so defective, that it is dangerous to the health of the public.

2nd. The disinfecting chamber was allowed to be out of order for a considerable period and unfit for use.

3rd. Infected houses, reported as such to the Sanitary Department, have not been attended to or disinfected.

4th. The authorities have not paid proper attention to the providing of proper ash-pit and privy accommodation for the poor.

5th. Public conveyances have not been provided for carrying patients affected with contagious diseases to hospital, nor for the conveyance of infected clothing to and from the disinfecting chamber.

6th. Inspection of tenement houses is not properly carried out.

None of these charges have met with any substantial denial. The scavenging has not been defended. It was denied that the disinfecting chamber was out of order, but a newspaper reporter found the charge to be true, and then the defect was remedied, and a notice issued, requesting the public to use the chamber. That the reports of infected houses were not attended to, was found by numerous instances published in the public press, especially in the *Saunders's News-Letter* and *Freeman's Journal*. The state of the ash-pits has been proved in a similar manner. No public conveyances for the sick were supplied until the public were alarmed by prosecutions of car drivers for conveying small-pox patients to hospital. That the inspection of tenement houses has been neglected, is proved by Mr. Norwood's letter to *Saunders's News-Letter* (see Appendix A), and the editor's remarks thereon.

This break down of our sanitary arrangements is after a five years' trial of the present system. I believe the time has been long enough to prove that system unworkable. I believe it to be unworkable for two reasons. First, that the working staff is insufficent, and the chief officers badly paid. Secondly, that no sanitary system could possibly work under a body constituted as the Dublin Corporation is at present. Many members of the Corporation are interested in the property, which it should be the duty of a proper sanitary organization to overlook. Thus, some members of the Corporation are owners of tenement houses; others are elected by the owners of such houses; others again, especially the publican class, are supported altogether by customers who own or inhabit those houses. Such being the state of things, we must look elsewhere for a proper authority (to be the nuisance authority as the Act of Parliament hath it). The Boards of Poor Law Guardians in Dublin are constituted in much the same way as the Corporation, and, in point of fact, (excepting the *ex-officio* guardians), are, to a great extent, composed of the same members. At present the Poor-Law Commissioners are the only body we can look to to carry out a proper sanitary organization in this country.

I would suggest, as a sanitary organization likely to be efficient in

Dublin, one composed in main of the Medical Officers of the Dispensaries, with a general Health Officer placed at their head. The advantages of such an organization would be very great, for the following reasons :—

1st.—That the city is already divided into districts, for the purpose of Medical attendance on the poor, registration, and vaccination.

2nd.—That the Dispensary Medical Officers are the first to know of sanitary defects, or of the outbreak of epidemic.

3rd.—That it is the direct interest of the Dispensary Medical Officers to maintain their districts in the best sanitary condition possible, as their work is thereby much diminished, and the difficulties and dangers of attending on the sick reduced to a minimum.

There are seven Dispensary Districts in Dublin, each of these have two Medical Officers, and to each a Sanitary Inspector should be attached.

This would give the following sanitary organization for the city of Dublin, and I have made a rough estimate of the cost of such an organization.

A Health Officer, who should, if possible, be attached to a large Hospital, as a Physician or Surgeon, but who should not engage in private practice, at a salary of £600 a-year ..	£600
Fourteen District Health Officers, who should, of necessity, be the Dispensary Medical Officers of their respective Districts, at salaries of £50 a year each	700
Seven Sanitary Inspectors, one for each of the seven City Dispensary Districts, at salaries of £40 a year each ..	280
A City Analyst, at a salary of £150 a year, with all fees for Analysis	150
A Secretary to the department, at a salary of £200 a-year ..	200
Total	£1,930

I believe this organization might, with safety, be extended, so as to include the Suburban Districts, and thus bring the whole Dublin Districts within the control of the Chief Health Officer.

The other expenses are not easily estimated, for as matters stand at present, a very considerable outlay would be necessary in order to enable the new organization to start fair; but I believe once fairly started, the system, as proposed above, would be worked at an expense little exceeding the salaries of the staff.

I suggested a plan, such as this, several years ago, in a letter to *Saunders's News-Letter*, signed " Hospital Physician."

The plan may appear costly, but health is cheap at any price, and for the last five years there has been an annual expenditure of something like £1,500 a year, and we have absolutely got nothing for it.

APPENDIX E.

THE PRINCIPAL PROVISIONS OF THE SANITARY LAWS AS APPLICABLE TO IRELAND.

1. The sanitary laws now in force in Ireland are contained in the Sanitary Act of 1866, and the several Acts incorporated with and referred to in that Act, and in the Sanitary Act (England) of 1868, which was extended to Ireland by the Local Government Act (Ireland), 1871, which came into operation on the 1st September, 1871.

2. In Ireland the Town Councils and Commissioners, as set forth in the Schedule to the Sanitary Act of 1866, are the Nuisance and Sewer Authorities in all towns under councils or commissioners; in all other cases the Guardians of the Poor constitute such authorities.

3. By Section 49, Sanitary Act, 1866, if the Sewer or Nuisance Authorities neglect or make default in carrying out the provisions of the law, the Lord Lieutenant, on being satisfied after due inquiry, of such neglect or default, is enabled to make an order limiting the time for the performance of the particular duty, and in default to appoint some person to perform such duty, and to recover the expenses and costs thereof from the local authorities.

4. By the 16th Section of the same Act provision is made against Nuisance Authorities neglecting to compel private persons to abate nuisances. Upon complaint to the Lord Lieutenant of neglect of the Nuisance Authorities to institute proceedings under the Act, his Excellency may authorize the Chief Officer of Police to take any proceedings which the Nuisance Authority might have taken for the removal of nuisances, the expenses and costs thereof to be borne by the authorities, in default.

5. The nuisances against which more effectual provision is made by the Act, 1866, sec. 19, are :—

1st. Over-crowded houses.
2nd. Over-crowded or uncleanly work places.
3rd. Smoke from the chimneys of manufactories.

The nuisances provided against by the Nuisance Removal Act of 1855, are :—

1st. Premises injurious to health.
2nd. Any pool, ditch, gutter, watercourse, privy, urinal, cesspool, drain, or ash-pit, so foul as to be injurious to health.
3rd. Animals so kept as to be injurious to health.
4th. Any accumulation or deposit injurious to health.

The Act of 1855 also contains special provisions against :—

1st. Foul water.
2nd. Corrupting water with gas-washings.
3rd. Sale of unwholesome meat.
4th. Noxious trades or manufactories.
5th. Nuisance in mews or stables.

6. Notice of nuisances may be given to the Nuisance Authorities—

1st. By any person aggrieved thereby.
2nd. By the Sanitary Inspectors, or any paid officer under the Nuisance Authorities.
3rd. By two or more inhabitant householders of the parish or place to which the notice relates.
4th. By the Relieving Officer of the Union or Parish.
5th. By any Constable or Officer of the Constabulary or Police Force of the district or place.
6th. By any person appointed to inspect Common Lodging Houses, in case the premises be a Common Lodging House.

7. The Nuisance Authority (or the Chief Officer of Police acting under sec. 16, Sanitary Act of 1866), previous to taking proceedings before a justice, under the 12th section of the Nuisance Removal Act of 1855, must serve a notice on the person by whose act or default the nuisance arises; or if such person cannot be found or ascertained, on the owner or occupier of the premises, to abate such nuisance, and execute all necessary works within a specified time.

If the nuisance arises from the want or defective construction of any structural convenience, or where there is no occupier of the premises, the notice is to be served on the owner.

When the person causing the nuisance cannot be found, or it does not arise by the act or default of the owner or occupier, the Nuisance Authority may itself abate the nuisance without further order.

8. Common Lodging Houses, *i.e.*, houses in which beds are let by the night, to persons who have no fixed residence, are regulated by the Common Lodging House Acts, of 1851, 1853, and 1860.

Houses not being Common Lodging Houses, but let in tenements, are regulated by the 35th section of the Sanitary Act of 1866, and the regulations made by the Nuisance Authorities under that section, such regulations having been confirmed by the Lord Lieutenant in Council; offences against those regulations are subject to a penalty not exceeding 40s., with an additional penalty not exceeding 20s., for every day during which a default in obeying such regulations may exist. Regulations relating to Dublin were made by the Nuisance authorities, and approved of by the Lord Lieutenant, and bear date 4th December, 1866. Some of those regulations are—"That no greater number of persons shall occupy any room in any such house than can be accommodated with 300 cubic feet of space for each;" "That the owner shall mean the person or persons who, for the time being, shall be in receipt of the rents of the lodgers or other occupiers of such premises." That such owner shall supply proper ash-pits, privies, and water-closets, house drains connected with the main sewer, and keep same properly cleansed, and shall provide a sufficient supply of pure water, and also provide for the cleansing and ventilation of the premises. That no occupant residing in such house, or any other person, shall throw from any window upon any roof, shed, yard, passage or street, any water, foul liquid, or other offensive matter, or drop same in or upon any common entrance, staircase, lobby, street, or place, other than that provided for the proper deposit thereof.

9. By section 26, Sanitary Act of 1866, "It is provided that where an hospital or place for the reception of the sick is provided within the district of a Nuisance Authority, any justice may, with the consent of the superintendent body of such hospital or place, by order, on a certificate signed by a legally qualified medical practitioner, direct the removal to such hospital or place, *at the cost of the nuisance authority*, of any person suffering from any dangerous, contagious, or infectious disorder, *being without proper lodging or accommodation, or lodged in a room occupied by more than one family*, or being on board any ship or vessel." From this section it would appear that the removal can only be made when the person is affected with dangerous, contagious, or infectious disorder, and *has not proper accommodation, or is lodged in a room occupied by more than one family*. This section does not apply to common lodging houses. The 7th section, Common Lodging House Act of 1853, provides for the removal to hospital by the local authority on the certificate of the medical officer of the parish, place, or district, of any person suffering from fever or any contagious or infectious disease.

10. By Section 37, Sanitary Act, 1866, the Sanitary Authorities may provide for the use of the inhabitants within their district, hospitals or temporary places for the reception of the sick. They may also provide and maintain a carriage or carriages suitable for the conveyance of persons suffering under any contagious or infectious disease, and pay the expense of conveying any person therein to an hospital or place for the reception of the sick.

11. Under the 34th sec. Sanitary Act, 1866, the Nuisance Authority may enforce payment of any costs and expenses which the owner of any premises may be liable to pay, under the Nuisances Removal Act, or under the Sanitary Act of 1866, either against the owner or occupier, and the owner shall allow the occupier to deduct any sum which he so pays out of the rent from time to time being due in respect of the premises, provided that nothing contained in that section shall affect any contract between the owner and the occupier as to the payment and discharge of any rates, dues, or sums of money payable in respect of such premises, or to affect any contract whatsoever between landlord and tenant.

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Presented to the Medical Staff Library.

THE INFLUENCE OF THE PRESENT KNAPSACK AND ACCOUTREMENTS ON THE HEALTH OF THE INFANTRY SOLDIER.

By W. C. Maclean, Esq., M.D., Deputy Inspector-General, Professor of Military Medicine, Army Medical School, Netley.

From the Journal *of the* Royal United Service Institution, *vol.* viii.

Mr. Chairman and Gentlemen,—I purpose this evening to call your attention to the influence of the present knapsack and accoutrements on the health of the infantry soldier.

Whatever may have been the case in times past, it is certain that everything bearing on the health and happiness, the moral, and physical well-being of the soldier, is now a subject of anxious consideration to the authorities, and of interest to the community at large.

After much careful inquiry into barrack and hospital accommodation, including the important subjects of ventilation, drainage, and surface space, very considerable improvements have been carried out, with the results of diminishing sickness and mortality in a very remarkable manner. Increased attention to clothing, food, moral, and intellectual training, and wholesome recreation, has gone hand in hand with the other improvements, and materially contributed to the end in view.

Among the improvements just mentioned, few were more imperatively called for than those affecting clothing. If time and the occasion admitted, it would not be a difficult task to show, that for a long period of time the inventive genius and good sense of this country were not seen to much advantage in military costume. The "follies of the wise" have often been conspicuous in the clothing and equipment of our soldiers. The generation familiar with heads laboriously soaped, powdered, plastered, and pigtail-tied, has only just passed away. The satirist who sang—

> "God bless the Guards, tho' worsted Gallia scoff;
> "God bless their pigtails, tho' they're now cut off,"

has not long disappeared from the clubs of London.

It is only within the last few years that any difference worth naming, was to be seen in the dress of the British soldier in Calcutta, and one quartered at Chatham.* A very few years ago I saw a batch of unhappy recruits learning their drill at Arcot, the hottest station in the hot Carnatic, buttoned up in red jackets, lined with stout serge, that had been served out to protect them from the cold of the English Channel.

The great bulk of the British army embarked for service in the Crimea, clothed in tight-fitting coats, the skirts of which had been pared away until nothing remained but a ridiculous appendage, fondly imagined by tailors to resemble the tail of a swallow. We still see these garments in Monmouth-street, and on the persons of deputy-lieutenants of counties, on occasions of state. In the museum at Netley, we have a collection of military head-dresses, most wonderful to look at. Yet they were very dear to their contrivers, and—in another sense—to those who had to carry them on their heads in all climates, from Canada to Cawnpore. Most of them, I have no doubt, are familiar to many gallant officers present; they are old acquaintances of my own, for I may truly say I have seen nearly all of them "Dance into light, and die into the shade." We preserve them for the wonder, if not for the admiration, of generations to come. Then we had the leather stock, we all remember it well; how long it stood its ground, how hard it was to get rid of; and I have no doubt that, like myself, some of my audience are acquainted with a few elderly friends who cherish the memory of that garotting apparatus to this day.

Forgive this retrospect at past errors; trivial, ludicrous even as some of them now appear, they were each in their time and degree causes of suffering, sickness, and premature death.

If we have made mistakes, let us not be ashamed to own them, and let careful study teach us to avoid them for the future. On my appointment, three years ago, to the chair of military medicine, in the Army Medical School, I was placed in a position where I could study on a large scale the chief causes which influence the health of the army. As at Fort Pitt formerly, so now at Netley, the invalids from all parts of the world may be said to pass in review before the

* Professor Longmore assures me that the tunics and trowsers issued to his old regiment in Bengal, during the mutiny, were heavier than those worn in Canada.—W.C.M.

medical officers of that great establishment, who have thus an opportunity of examining men who have served in almost every region of the globe, and observing on their persons the effects of service in various climates, and the influences hostile to health to which they have been exposed; and while it is the chief duty of the Professors of the School of Military Medicine to teach the young medical officers the many valuable lessons derived from such an immense field of observation, it is no less their duty, from time to time, to give to the authorities such information as may lead to improvements calculated to promote the health and happiness of the soldier, to diminish suffering and mortality; to lessen cost, and promote efficiency. It is because I conscientiously believe that the subject to which I am about to call your attention this evening has important bearings in all these directions, that I have determined to lay it before the members of this admirable Institution, convinced that nowhere could I find an audience more capable of understanding the great practical importance of the inquiry, or more interested in its right solution.

I had not been long in the position I have the honour to fill in the public service, before I became profoundly impressed with the vast losses sustained by the prevalence in the army of consumption and diseases of the circulatory system, that is, of the heart and great vessels. Within the last three years, excluding those who die in regimental and depôt hospitals, and those of the Household troops (I exclude all invalided in Ireland, of whom we at Netley see nothing), no less than 1,344 men have been lost to the service from consumption alone. Now the causes in operation tending to produce this enormous and costly loss are many and complicated.* That the present accoutrements and knapsack, interfering as they do with the free play of the important organs within the chest, exert an important influence in this direction, I do not doubt; but as the proof of this would lead me into details, and involve many points of inquiry not suited for discussion here, I shall not go further into it on this occasion, but will direct your attention to another source of inefficiency, which can be more directly traced to the *mischievous constriction* to which we subject the chests of our soldiers at the time we demand from them the *maximum* of *exertion*.

Between the 1st of July, 1860, and the 30th of June, 1861, 2,769

* A very general impression prevails that the recommendations of the Royal Sanitary Commissioners as regards the amount of cubic and superficial feet per man in barracks has been universally carried out. This, however, is far from being the case. The home regulation is 600 cubic and about 60 superficial feet per man, but even this *minimum* is rarely enjoyed by the soldier.

In Chatham the average cubic space is only 450. In hot Gibraltar the Barrack Commissioners report that no fewer than 3,617 men have under 450 cubic feet each, and 5,253 have less than 40 square feet each. While such a state of things exists, we cannot be said to have taken a single step to mitigate, much less remove, what is certainly the master sin of our whole system, viz., overcrowding in barracks.

According to General Morin, the reporter of the commission ordered to determine the ventilation of the Palais de Justice and the new theatres of Paris, as quoted by Dr. Parkes, to keep the air pure there must be supplied—

In barracks, by day, 1,060 cubic feet per head per hour.
" by night, 2,120 " " " —W.C.M.

men were discharged the service at Fort Pitt; of these 445 (or 16·07 per cent.) were under 2 years' service; and of these 445 discharges, *heart diseases* made up 13·7 per cent. From the 1st July, 1861, to 30th June, 1862, 4,087 men were discharged the service; 569 of them (or 13·92 per cent.) had less than 2 years' service, and of these, 14·76 per cent. were lost to the service from *heart diseases*.

From the date of my assuming charge of the medical division at Fort Pitt, in April, 1861, to the end of last year, no less than 883 cases of diseases of the circulatory system—in other words a number nearly equal to the strength of a battalion,—have passed under my observation, and been lost to the service, and this from one class of disease; the great bulk of the cases being young men returned to the civil population (that is, cast upon their parishes), and incapable of earning their bread in any active employment. The pension allowed to such short service men is but a pittance, and that pittance is granted only for a limited period. Let me remind you again, that in the figures I have given, the invalids of the Royal Artillery, the Guards, and the troops serving in Ireland, are not included; they were discharged without being seen by us at all.

Surely, gentlemen, you will agree with me, after hearing a statement so startling, that it behoves us to look narrowly into a question involving such an amount of suffering, costly invaliding, and inefficiency, with a view to the adoption of a remedial measure.

Before I address myself to an examination of the accoutrements and knapsack, and show the evils they induce, I must advert for a moment to three causes, which are supposed to exercise a disturbing influence on the organs of circulation, and to act either as predisposing or exciting causes of disease of the heart, viz., rheumatism, intemperance, and excessive smoking.

Rheumatism affects the fibrous structures of the frame; these structures enter into the formation of the delicate valves of the heart, and these valves are apt to suffer from this disease, to have their mechanism injured, and so to interfere prejudicially with the working of the heart—the central moving power. Now, many cases of heart disease can be traced to this cause, and soldiers, from the very nature of their calling, are of course much exposed to rheumatism; but, making a fair allowance for this, particularly among old soldiers, an immense number of cases remain that cannot be accounted for in this way. A vast number of the young soldiers discharged the service for heart disease have never suffered from rheumatism at all.

With regard to intemperance, it is undeniable that the presence of alcohol in the blood exercises a prejudicial influence on the heart and great vessels, as well as on other organs, but here we have the same difficulty to meet, viz., that a large proportion of our young lads are lost to the service from heart disease ere they have contracted the baneful habit of spirit drinking.

Nor do I deny that excessive abuse of tobacco may in many cases result in an irritable condition of the heart, incapacitating a man from much exertion; but I think there is no proof that young soldiers smoke more than other classes of the population.

Is it that soldiers are called upon to make greater exertions than the labouring and manufacturing classes? Doubtless the soldier has at drills, marches, and field-days to put forth considerable exertion; but is this more than, or so much, as we see daily done by our "navvies," and others of the labouring classes? I think not. We must look, then, to the different conditions under which the two classes work. A labouring man or mechanic, when he addresses himself to his work, lays aside every weight, and every article of dress that can in the slightest degree interfere with the free movement of his chest and limbs. In like manner, the sportsman, or the Alpine tourist, adapts his dress to the work in which he is engaged. But the soldier on the other hand, is called on to make the severest exertions, at the utmost possible disadvantage as regards the weight he has to carry, the mode in which he has to carry it, and the entire arrangement of his dress and equipment.

The function of respiration in health, when we are not unduly exerting ourselves, is carried on with so much ease and regularity, that we are hardly conscious of the action of its complicated mechanism; we draw air into our lungs and expel it without an effort. It is only when we experience in our own persons, or witness in others, the effects of even a momentary interruption to the due performance of this function, that we become aware of its vital importance to our very existence. Three minutes' total suspension of respiration, and we die. So essential is respiration to existence, that it is placed under the control and guidance of a part of the nervous system apart from the will, and it is only when the function is interfered with by disease or excessive exertion, that the assistance of muscles, under the direct control of that will, is called in to aid us in the struggle for the free admission of that air, without which we die. Let us glance for a moment at the chest and its contents.

I have here the framework of the torso or trunk. Within the elastic walls of the chest are placed the lungs, the heart, and the great vessels leading from it, and these fill it equally in all its alterations of size; it is so contrived, as to shield these vital parts from injury (save of course from injury of an extreme degree), and yet to give them that free play, without which their functions cannot be performed. You observe its construction—consisting of the spinal column behind, itself made up of many separate pieces, with an elastic fibro-cartilaginous cushion interposed between its separate parts, represented artificially here, the breast-bone in front, and the ribs, or osseous arches, enclosing the chest. Note that each rib has a cartilage of prolongation; these are of great strength, and very elastic. By their means, the seven true ribs are connected directly to the breast-bone, those of the remaining ribs, merely to each other. You cannot fail to observe that there is here unequivocal evidence of a provision for motion. Let us look now at the movements to which this anatomical arrangement points.

During inspiration, the collar bones, first ribs, and through them the breast-bone and all the annexed ribs, are raised; the upper ribs converge, the lower diverge, the upper cartilages form a right angle with the breast-bone, and the lower cartilages of opposite sides, from the seventh downwards, move further asunder, so as to widen the abdominal space between them, just below the point of the breast-bone; the effect being to raise, widen, and deepen the whole chest, to shorten the neck, and apparently to lengthen the abdomen. During expiration the position of the ribs and cartilages is reversed; the breast-bone and ribs descend, the upper ribs diverge, the lower converge; the upper cartilages form a more obtuse angle with the breast-bone, and the lower cartilages of opposite sides approximate, so as to narrow the abdominal space between them, just below the point of the breast-bone; the effect being to lower, narrow, and flatten the whole chest, to lengthen the neck, and apparently to shorten the abdomen. During inspiration, the movement of the lungs and heart is downward.*

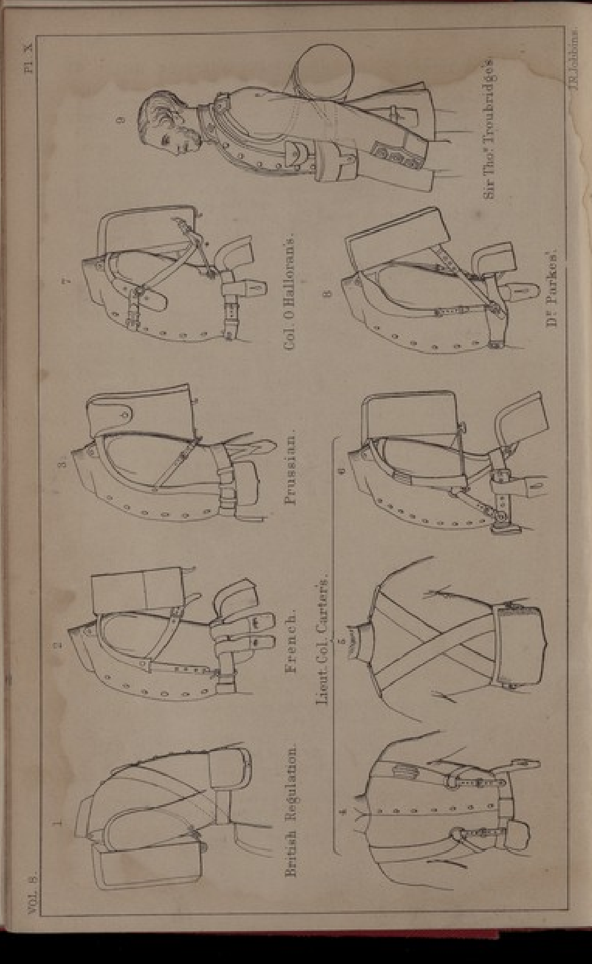
Let us now inquire whether there is anything in the mode in which the soldier is weighted and accoutred likely to interfere with these natural movements more or less at all times, and particularly when making severe exertion. And here I must take the opportunity of saying that this question has been very carefully examined by the professors of the Army Medical School; and, after mature consideration and inquiry into the whole question, we have arrived at the conclusion that the present accoutrements are highly injurious to the health of infantry soldiers, and have a large share in producing many affections of the lungs and heart common among them; in fact, so impressed have we been with the importance of the subject, that, in conjunction with Major Deshon, 2nd Depôt Battalion, an officer who has paid a great deal of attention to these points we made two reports on the pack and accoutrements of the infantry soldier, which reports were presented to the General commanding at Chatham. From these reports I shall quote largely in the course of the following observations. It will perhaps be well for me to mention that two great military nations, France and Prussia, have experienced the inconvenience of a faulty system of accoutrements to such an extent that they have introduced improvements intended to relieve the soldier from injurious pressure upon his chest and abdomen, and to interfere as little as possible with the free action of his muscles and organs,

The weight of the British soldier's clothes, great coat, field kit, and canteen, with 60 rounds of ammunition and 75 caps, havresack, bayonet, rifle, and sling, pack and straps, pouch, &c., &c., is 48 lbs. $5\frac{1}{4}$ ozs.

If the soldier has to carry his blanket, as in the field, with rations for three days, and his water-bottle, an addition of 12 lbs. is made, making in all 60 lbs. $5\frac{1}{4}$ ozs.

Let us now look a little closer at the regulation pack. In the diagram before you (Plate x., Fig. 1) is a drawing of it. You cannot fail to see that the whole weight of the pack is thrown on the

* Vide Sibson's Medical Anatomy.—Here Dr. Maclean showed a figure in outline, displaying the extent of these movements, and also a skeleton of the trunk, showing its framework, &c.—Ed.



straps passing under the arms; the pouch and a small packet for caps are carried on the belt, which runs diagonally across the chest, and the bayonet and ball-bag are carried on the waist-belt; the belts are therefore so disposed as to press most injuriously on the chest; the cross-belt, stretched by the great weight of the pouch, impedes the forward movement of the ribs; the waist-belt hinders the expansion of the inferior false ribs, which, as we have just seen, in the state of unrestricted movement, is very great; and the pack-straps press on important muscles, arteries, veins, and nerves to a degree which only those who have carried the loaded pack can appreciate. The weight, especially when the great coat is strapped on, falls to a great extent behind the line of the centre of gravity. Now these objections are by no means merely theoretical; soldiers universally complain of the sufferings they endure from the pack and present accoutrements, and if you closely question the sufferers from heart disease, you will find how closely they connect their complaints with these belts and packs.*

It is certain that at no period was the pack more worn that at present. I find that it is worn at least once a day on regimental parade, and on all brigade and field days at all the camps in this kingdom. I have been at some pains to ascertain from regimental medical officers the effects observed on the men, particularly on field days. Some do not appear to have paid much attention to the subject, but the majority seem alive to the ill effects of the pack and accoutrements.

Many men fall out in a state of extreme distress, and many surgeons assure me that nothing but a strong feeling of *esprit de corps* prevents many more from doing so. In all well-disciplined regiments the practice of falling out at drill or on the line of march is discouraged, and men will bear and suffer much, rather than incur the imputation of being "soft"—some, to my own knowledge, have worked on through a field day, and have died rather than give in. An instance of this occurred at Aldershot on a field-day last summer.

In the first of the reports on packs submitted for the consideration of the General commanding at Chatham, by the professors of the Army Medical School, the following were the general principles insisted on:—

1. To distribute the weight, as far as practicable, over the body.
2. To bring the weight, as far as possible, within the line of the centre of gravity.
3. To allow no pressure on the principal muscles, nerves, arteries, or veins.
4. To avoid most carefully all impediment to the fullest expansion of the lungs, and to the action of the heart.

This rule is a cardinal one. Unless the circulation through the lungs be quite free, continued exertion becomes impossible. The commonest experience shews that the number of respirations,

* Here the Professor showed a preparation of a human heart, taken from the body of a soldier, with a white spot or corn on it, which he explained arose from the pressure and friction to which the organ had been exposed. He further stated that this "corn," rare in civil life, is the rule and not the exception in the bodies of elderly soldiers.—Ed.

and the amount of air drawn into and expelled from the lungs, is enormously increased by exertion. Late physiological inquiries have shown that the elimination of carbonic acid is also prodigiously augmented, and this is a necessary sequence of the muscular contraction. If this elimination be prevented by any interference with respiration, no amount of energy or volition on the part of the man will enable him to continue his exertion. Trainers, both of men and horses, have long been aware of this fact.

I have just shown you how impossible it is to carry out such principles as these with the regulation pack, which is constructed as if for the purpose of transgressing them all.

Fig. 2 shows the French pack, that worn by the Chasseurs de la Garde. It is secured by straps going under the arms, as in the English pack; but it is an improvement on the latter, as two straps run down from the arm-straps to the waist-belt, and so relieve in great measure that excessive pressure on the arms so much felt by our men. It approaches the Prussian pack, but is not so good; the pouch (which is small) is carried on the waist-belt behind, and there is no cross-belt whatever; the lungs have therefore very fair play with this pack, the amount of ammunition is, however, smaller.

Fig. 3 shows the Prussian pack and accoutrements. You see that they are arranged differently from any of the others. The ammunition is carried in two pouches attached to the waist-belt, capable of carrying each 20 rounds of English ammunition, and 15 of Prussian. The pack fits to the back, to which it lies as close as possible. Two broad straps pass from the top of the back over the shoulders and fall to the waist-belt, to which they are joined by two brass hooks.

Two other straps run from the lower part of the pack and join these shoulder-straps, so that the pack is quite steady, and its weight is counterbalanced by the pouches in front.

This pack is much superior to ours; it exerts only moderate pressure on the lungs, and none on any muscles or vessels; the weights are close to the body, and the weight of the pack falls within the centre of gravity. The arms have full play. In the trials conducted by us, this pack was invariably preferred by the men to our own, although it was not rated so highly as others.

Figs. 4 and 5, show front and back views of Lieutenant-Colonel Carter's accoutrements. Fig. 6, side view of accoutrements and pack. The pack is supported by two straps passing over the shoulders and hooking on to two iron rods, which project forward from the lower end of the pack; the front of the pack is concave, and is made of wicker work; its weight is very great, and it is altogether too large.

It is, however, a vast improvement on the regulation pack. It is borne on the shoulders, and does not press at all on the lungs, or upon any muscles, nerves, or vessels; the arms are quite free. The pouch, which is a large one, hangs away from the body too much. It is, however, carried easily. The belts are too heavy and complicated. In our trials the men reported favourably on this pack, all who tried it declaring it to be an immense improvement on the regulation pack.

The next is Berrington's pack, adapted with Colonel Spiller's rods by Colonel O'Halloran (Fig. 7). The belt represented in this drawing as passing across the chest is done away with in Colonel O'Halloran's improvement pack.

It is carried by means of two flexible steel plates lying in front of the chest, and having attached to them two straps passing from the lower end of the pack beneath the arms. Two rods, with a broad strap between them, support the lower part of the pack against the small of the back; no muscles or vessels are pressed upon, and the arms are perfectly free. The weights are tolerably close to the centre of gravity. With this pack, the pouch and bayonet are carried as in the regulation pack. The steel plates were thought by us an objection to this pack, as by their breadth they, in some degree, press on the ribs in inspiration. The pack, however, in our trials was favourably reported on.

A pack contrived by my colleague, Dr. Parkes (Fig. 8), was also tried. The principle of it is to throw the weight in part on the hips, by means of two straight iron rods running from the bottom of the pack, and fitting into two sockets in a hip-belt. The principle of this pack is sound, but there is great objection in this, as in the others, to the iron rods, which, if broken on service, cannot easily be replaced. They are also dangerous, for if struck in action the fragments would almost certainly be driven into the body of the wearer, or that of a comrade in the ranks. The conclusion come to by us, after a careful examination of all these packs, and carefully conducted trials with them all, was, that the regulation mode of carrying the pack was the worst of all; but good as some of the proposed plans are, none of them seem perfectly to answer all the required conditions.

Lieutenant-Colonel Carter and Colonel O'Halloran were not the only officers who saw the necessity of introducing a new and a better mode of carrying the pack.

Sir Thomas Troubridge exhibited at the last great Exhibition a valise, which I now show you (Fig. 9), and on which we (the professors) made a special report to Major-General Eyre, Commanding at Chatham, an officer who has taken a great interest in this question, and who gave us his cordial co-operation in investigating it.

This pack is carried in a mode different from any of the others. A yoke, on the principle of the milkmaid's yoke, is fixed on the shoulders; from this two metal rods (of tubular copper or of steel) pass down in front of the arm-pits, which they do not touch, and are hooked behind to a round bag or valise (without any frame), which is carried on the small of the back, or just above the hips. The weight of this valise is chiefly thrown on the shoulders, but it is also partly thrown on the strong hip-bones, in this resembling Dr. Parkes'. There is not the least pressure, either on the chest or on the arm-pits.

As the valise is thus carried so low down, the ammunition cannot be carried in a pouch behind. It is, therefore, placed in two pouches in front (each intended to carry thirty rounds), and a strap passes round the back of the neck, and hooks into each pouch.

A waist-belt carries the bayonet, and keeps the two pouches steady;

the pouches thus balance one another, instead of, as in the Prussian plan, the pouches balancing the pack.

The great-coat can be carried either on the top of the valise, or in a roll over the shoulder.

On considering the mode in which the weights are distributed on this plan, it is evident that it satisfies all the conditions which we formerly enumerated as essential to a perfect system.

Not the slightest pressure is made on the lungs; no great muscle, vessel, or nerve, is pressed upon; the weights are close to the centre of gravity, and are as near the line of the centre of gravity as they can be; while the strongest parts of the body, viz., the tops of the shoulders and the hip-bones, carry the weights.

As far as mechanical and physiological principles are concerned, we see nothing wanting in this plan. The weight, in pounds and ounces avoirdupois, of Sir Thomas Troubridge's valise, with kit, ammunition, &c., is 17 lbs. 12¾ oz.

Any one who has seen the enormous weights carried by the Canton water-bearers, or the Banghy Burdars and palankeen-bearers of India, all borne on the shoulder, in such a way as not to interfere with the free play of the chest, will see that Sir Thomas Troubridge has thus hit on the right principle for carrying the soldier's pack and ammunition. We submitted this plan to a trial against O'Halloran's pack, as improved and exhibited in the last Great Exhibition.

Four experienced non-commissioned officers, and privates, after being carefully examined by me to see that they were free from chest disease, were marched eleven or twelve miles accompanied by Major Deshon, who closely watched them: they used the pack and valise alternately, and on returning, their unprompted statements were taken down by me verbatim. Without going into details, I may say that the reports of all the four men were identical: they all praised Colonel O'Halloran's pack, and thought it much better than the regulation, but they reported of the valise that it was as superior to Colonel O'Halloran's pack, as that was superior to the regulation.

The ease of breathing, the freedom of the arms, the apparent lightness of the weights, the absence of fatigue or exhaustion at the end of the march, with Sir T. Troubridge's accoutrements, were all points strongly insisted upon by these experienced non-commissioned officers and soldiers; nor did they hesitate to affirm that the efficiency of the soldier would be increased to an immense extent by their adoption throughout the service.

In conclusion, I trust that some of the distinguished officers present may be induced to inquire into this subject for themselves, to make comparative trials with the packs just exhibited, and with the contrivance of Sir Thomas Troubridge; if any can be induced to do so, and to investigate it thoroughly, I feel convinced they will find that my colleagues, and the gallant officers who have co-operated with us, have not exaggerated its importance. I am quite aware that the introduction of a new knapsack into the service would be a very costly measure; but if once the fact is established that the present knapsack is costly from the amount of invaliding it

entails, and cruel from the suffering it causes, enough will be done to warrant, at least, the gradual introduction of a better. To an audience such as this, I need hardly add, that the tendency of modern tactics, all over the world, is to rapid movements in the field, and if it is insisted on, that modern soldiers shall march and fight with their kit on their backs, it is obvious that this should be so placed, as to embarrass their movements to the smallest extent, if not they must fight and march at a grievous disadvantage.

The CHAIRMAN: I am sure Dr. Maclean will be ready to answer any question that any gentleman may wish to put, or should any gentleman wish to illustrate the subject by mentioning the results of his own experience, we shall be very glad to hear him. If no one has any observations to make, I am sure you will now join me in a vote of thanks to Dr. Maclean for the interesting lecture we have had, and for the able manner in which he has delivered it.

We will now proceed to call upon Dr. Domenichetti to begin his lecture.

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SANITARY PRECAUTIONS TO BE OBSERVED IN THE MOVING AND CAMPING OF TROOPS IN TROPICAL REGIONS.

By Surgeon-Gen. W. C. Maclean, M.D., C.B., Professor of Military Medicine, Army Medical School, Netley.

(For private circulation only.)

Evening Meeting.

Monday, 16th February, 1874.

SIR T. GALBRAITH LOGAN, M.D., K.C.B., Director-General, Army Medical Department, in the Chair.

SANITARY PRECAUTIONS TO BE OBSERVED IN THE MOVING AND CAMPING OF TROOPS IN TROPICAL REGIONS.

By Surgeon-Gen. W. C. MACLEAN, M.D., C.B., Professor of Military Medicine, Army Medical School, Netley.

MR. CHAIRMAN AND GENTLEMEN,—I appear before you this evening in obedience to a call from the Council of the Royal United Service Institution, to address you on the "Sanitary Precautions to be "observed in the moving and camping of troops in tropical "regions." In the month of March, 1862, my colleague Professor Parkes, addressed you "On the causes of Sickness in the English "Wars, and on the means of Prevention." In the concluding sentences of his discourse on that occasion, Dr. Parkes congratulated you "that at last an enlightened policy has been initiated," and that "in the "words of Robert Jackson, the prince of Army Surgeons, the health "of the soldier had become 'a primary consideration of the State.'" And he added, "that it must be for the Army at large, and for the "general public, to support exertions which, without their aid, would "languish and disappear. It must be for us, in fact, not to forget the "teachings of the past, but to make them ever living; that their "warnings shall not be forgotten, and that their lessons shall not be "unfruitful."

It is, I know, a matter of sincere happiness to Dr. Parkes, and to those who labour with him in this cause, to find that the "teachings "of the past," as unfolded by him in the lecture under notice, have not been "unfruitful," and that their warnings have not been "forgotten."

This country has been called on, sorely against its will, to send a small portion of its land and sea forces to chastise an enemy in a climate "where fleets are silently dispeopled and armies melted away," but, unlike too many expeditions that in bygone years have left our shores for a like purpose, the force sent to operate on the Gold Coast has been provided not only with the appliances of modern war, but with everything that science could suggest and the national resources supply, to maintain health and efficiency under the guidance of an Officer, who, to military qualities of a high order, adds knowledge of, and respect for, the art which aims at the preservation of life, and the mitigation of human suffering.

It will be more convenient, and save much repetition, if, at the outset, I dispose of certain matters of importance regarding dress, water, and alcoholic stimulants.

Dress.

An immense stride in advance has been made in the mode of dressing the British soldier; as I had on a former occasion an opportunity of showing in this hall, up to the time of the mutiny of the Bengal Sepoys, one dress was supposed to serve his purpose for duty in India and Canada. This is no longer the case; Officers and men are not now exposed to the rays of a tropical sun, dressed in a manner calculated immeasurably to add to the sufferings and dangers of such exposure; and all who are impressed with the exceeding importance of the subject had the satisfaction of seeing, for the first time in our history, a body of men embark for African service, as comfortably equipped for the climate and work before them, as sportsmen starting for the moors on the 12th of August.

I have to congratulate the Army on another improvement hardly second in importance to the one just mentioned, viz., a vastly improved system of accoutring the soldier. I had, on the same occasion, an opportunity of bringing before the members of this Institution the mischief wrought by the old regulation system, which, while it set at nought all considerations based on the anatomy and physiology of the human frame, was, as a necessary result, most objectionable from a military and financial point of view, from the costly inefficiency clearly traceable to its use. The "Pack-Committee," of which my colleague Dr. Parkes was an active member, after years of patient experiment, at last introduced a system which has solved in a very satisfactory manner both the military and physiological problems submitted to them. We have only to ask any old soldier who has felt the pinch of the old, and the ease of the new equipment, for his opinion on the change, to be satisfied, that little as those whose withers have never been wrung by the old regulation pack and belts may think of it, it is in the estimation of those who have studied the subject, the greatest boon that has been conferred on the soldier since defensive armour was laid aside. The trials made of the new valise equipment in Prussia have elicited strong recommendations for its introduction into a service where efficiency is so much appreciated; and Professor Morache, of the School of Military Medicine, Val-de-Grâce, declares that the trials made in France are conclusive in its favour, and were so regarded, not only by the soldiers who carried it on marches extending to 32 kilometres = to 20 English miles, without any fatigue, but also by the Officers who superintended the experiments. It is true that the knapsack is not carried by the British soldier in India, but in the old system it was not the knapsack alone that was in fault; every part of the equipment was so contrived as to press with severity on the chest-walls, and to impede the functions of the vital organs within them. The improvements I have thus indicated release me from the necessity of saying more on the importance of allowing free movement to the organs of respiration and circulation, when men have to exert themselves in the heated atmosphere of the tropics.

Water.

It is hardly necessary to say that few hygienic points are of more importance than a supply of the best procurable drinking water for men on the line of march. If this is left to the discretion of the water-carriers in India, they will take it from the nearest available source. After all that has been said and written on this subject of late years, it must suffice to say, that impure water is capable of conveying into the system the poison of malaria, or the germs of dysentery or cholera. The testing and purification of water are now carefully taught to Army Medical Officers, who, under present regulations, are charged with the responsibility of seeing that this is done by all the means available; and in their efforts to effect this, they should be seconded and supported by those in military command.* Filters, such as those contrived by Captain Crease, should be mounted on wheels, and the water-carriers, who attend to the wants of the men, should be obliged to draw their supplies entirely from them. Company Officers cannot be too watchful on this point, and should be diligent in instructing their men in the danger of drinking impure water by the way. Nor should a large supply for douching purposes be neglected. This is necessary at all times in hot weather, whether the men march by night or day. It is on this that Medical Officers place their chief dependence in the treatment of most forms of sunstroke by day, or syncope from great heat radiated from the soil at night. Every soldier marching in the tropics should have some form of pocket filter in his haversack.

Spirits.

If there be any point of military hygiene that may now be regarded as settled beyond doubt or cavil, it is this, that spirits are not only not helpful, but are hurtful to the marching soldier, everywhere I believe, but nowhere more so than in hot climates. The

* The water at every station between Cape Coast Castle and the River Prah was carefully examined, and the best sources of supply selected by Surgeon-Major Gore.

evidence on this point is overwhelming. The Medical Officers of the French Army who have had great experience in the arduous campaigns in Algeria, denounce the spirit-ration as hurtful: and Dr. Morache, already quoted as a high authority on military hygiene, declares that unless coffee had taken the place of spirits, it would have been impossible for the troops to surmount the fatigues of what he justly calls *ces pénibles campagnes*. Were I the medical chief of an Army destined to take the field in a tropical climate, not a drop of spirits should, with my consent, accompany it, save what the requirements of the ambulance-service demanded. The evidence shows that wherever soldiers, by accident or design, have been cut off from the use of spirits on marches, on active service, in temperate climates exposed to wet and cold, or in the tropics to ardent heat, or in laborious sieges, they have maintained their health, spirits, and discipline far better than when the once-deemed indispensable grog was in daily use. My colleague Dr. Parkes, and the late Count Wollowicz, in a series of careful experiments on the use of alcohol carried on at Netley, and published in the Transactions of the Royal Society, have placed on a sure scientific basis what was before a matter of observation, and have established that alcohol, far from increasing the power of bearing fatigue, even when given in a quantity which many spirit-drinkers would deem within the limits of moderation, lessens muscular force; and a quantity in excess of this, it was shown, entirely destroyed the power of work. The reason, Dr. Parkes says, was twofold. There was in the first place *narcosis* and blunting of the nervous system—the will did not properly send its commands to the muscles, and the muscles did not respond to the will; and secondly the action of the heart was too much increased and induced palpitation and breathlessness which put a stop to labour. The inferences were "that even any amount of alcohol, although it did not "produce symptoms of narcosis, would act injuriously by increasing "unnecessarily the action of the heart, which the labour alone had "sufficiently augmented." For fatigue, rest and food are the proper remedies. Alcohol given alone under such circumstances can only stimulate the already nearly exhausted heart to fresh exertion. Under some very exceptional circumstances it may be a matter of absolute necessity to do this, but even then we must follow Dr. Parkes's rule, viz., to give spirits in small quantity, not more than an ounce of brandy, and if possible it should be mixed with Liebig's meat extract, which has a great power of removing the sense of fatigue. Dr. Parkes even gives a formula which is worth bearing in mind for use under such circumstances, as for example, when troops, after a fatiguing march, are obliged to engage the enemy without time for rest and food, he advises two ounces of red claret wine, with two teaspoonfuls of Liebig's extract in half a pint of water. Wine not being available, half an ounce of brandy or rum would be a good substitute.

I cannot leave this important subject without adding, that for twelve years at Netley, I have had unrivalled opportunities of studying the effects of habitual dram-drinking on the persons of our soldiers; and I add my testimony to the immense weight of evidence accumulated by medical men in civil and military life, to the effect that alcohol is one of the most active agents in causing degeneration of the human tissues, in other words, disease, premature decay and death. If this be true, as I believe it is, those Officers who, by precept and example, strive to wean their men from the practice of this our national vice, may with truth be said to be engaged in a patriotic work, and to deserve well of their country. Let me ask you to look at this alcohol question from another point of view. I hold in my hand a copy of a work known, I dare say, to many present, viz., "The Sepoy War," being the Private Journal of General Sir Hope Grant, edited by Captain Knollys, R.A.; a modest record of very distinguished service. At page 108, we have the following passage, referring to the siege of Delhi. "In order to "fight to perfection, British soldiers must eat, and they must drink. "Would they drank a little less. There never appears to have been "any lack of provisions, and vast quantities of spirituous liquors "fell into our men's hands. Drunkenness became fearfully rife, "entailing with it increased sickness, as well as a relaxation of disci-"pline, which it was necessary to repress with an iron hand." We all know the stake played for at Delhi. It was the Empire of India. Mark how alcohol put the issue in peril. Mark also that from this danger we were saved only by that unrivalled power of maintaining discipline which British Officers have shown at all times, in all places, and under all circumstances.

Coffee.

It is almost superfluous to add that the best substitute for alcohol is coffee or tea. The French Military Medical Officers vaunt, and with justice, the superiority of the light wines of their own country over the more strongly brandied wines of Spain and Portugal, and they point to the fact, that when used in moderation, the aromatic principles and the various salts they contain, exercise an effect on the digestive organs which is alike wholesome and agreeable. With all this, the best of them give a decided preference to coffee. Morache, in particular, is emphatic in his testimony, and is even eloquent in its praise as an article of diet, a safe stimulant, an aid to digestion, and an efficient refreshment under fatigue. Coffee forms no part of the ration of the French soldier in time of peace; but Morache does not hesitate to urge its issue instead of brandy, and he instances certain regiments in which the custom of substituting coffee for the morning *petit verre*, had much advanced the cause of temperance.

That a cup of hot coffee is the best preparation for the fatigues of a march, is indisputable, and it should never be omitted. It is much better that the men should have it before leaving their ground, and not at the half way halt as was common in my time in India: it invigorates them at starting, protects, especially the young soldiers, against the griping abdominal pains to which they are subject particularly in the dark and chilly hour preceding the dawn, and the vigour it imparts helps the system to resist the miasm which at this hour is most freely evolved from the soil. It is worthy of remark that coffee was first issued to European troops for this very purpose,

on the advice of the great Larrey, during Napoleon's Egyptian campaign.

The chief enemies we have to guard against in tropical marches, are, malaria, dysentery, sun-stroke, cholera, and in the yellow fever zone, the terrible disease so named. Malaria is a poison given off by the soil under certain conditions. Dr. Parkes observes that "when "a country is said to be '*unhealthy*,' it is simply meant that it is "malarious."

Malaria is a product of organic decomposition in soils, it is banished by the cultivating hand of man, by drainage, especially sub-soil drainage, and by such a system of agriculture as directs the energy of the soil to the production of healthy living vegetation. The skill of the chemist has never yet isolated this poisonous agent, we recognise it only from its effects on the organism, which have been known from very early times. It is the chief factor in the causation of the class of fevers known as intermittent and remittent, characterised by a remarkable impress of periodicity, and by a long catalogue of sequels in the shape of organic diseases, which may also be gradually developed without febrile manifestations. It acts with the greatest intensity on the human system in situations which are low and moist, abounding in vegetation undergoing decomposition, in jungly districts during or immediately after the rainy season, at the base of great mountain ranges, as in the terrais of India, those belts formed of detritus rich in organic matter retaining a large quantity of water and covered with rank vegetation. It is capable of drifting along plains to a considerable distance from its source, and aided by currents of heated air, it can ascend ravines in mountain ranges to an elevation of many thousand feet. Water absorbs it, and periodic fevers can be introduced into the system by drinking water thus contaminated. This absorbing power of water is often beneficial when a sufficient breadth of it is interposed between human habitations and its source. Belts of trees in like manner exercise a protective influence. An important practical point to be kept in mind is that so slight an elevation from the ground as the difference between the ground and the second floor of a house often gives comparative safety; nay, the difference between the level of the ground and that of an ordinary bed may often lessen the danger. How high must we ascend to get out of its influence? Supposing there be no local sources, such as marshes, and no ravines up which it may drift, safety may generally be obtained at an elevation of from 1,000 to 2,000 feet. The point of safety differs however in different regions of the globe. It is hardly necessary to give such familiar facts, but without some such statement, the precautions to be observed in marching troops through malarial regions would not be intelligible. In India the ordinary reliefs of troops are made in the season of the year when comparatively little malaria is evolved from the soil. There are jungles, to enter which at certain seasons is, if not death, certain fever, of the most dangerous type; the same place can at the proper season be traversed in perfect safety. Under the pressure of military necessity troops must sometimes be moved at all risks. I have known this done when no such necessity existed, and with the most disastrous effects. A General Officer whose name became in Spain imperishably associated with a regiment he had often led to victory, was in command in Madras when his old regiment landed; anxious to show favour to the successors of his old comrades, he determined that the regiment should at once occupy the pleasantest and most healthy station in his command. To effect this: another regiment then occupying it, must of necessity march more than 200 miles to a bad station in the midst of the rains through pestilential jungles. This was pointed out, with the inevitable consequences. The General was inexorable; the march was made, and when the condemned regiment reached its destination, a hundred sickly men were all that were capable of bearing arms, the rest were buried by the wayside, or were in hospital prostrated by fever, dysentery, and disease of the liver and spleen. For all purposes of service, the regiment was blotted out of the army list, until it was re-made, merely to indulge what was at best a bit of good-natured sentiment. A malarious district having to be traversed it should be done quickly. Night marches, always hateful to soldiers of all nationalities, are not under such circumstances to be thought of. In all climates they are to be avoided. They deprive men of repose at the time when nature most demands it, and for this nothing can compensate; they involve depression of spirits; even the light-hearted French soldier loses all his gaiety as he stumbles through the darkness; a night march is twice as fatiguing as one made in the cheerful light of day, and above all, it exposes the system of the soldier, at the time when it can offer least resistance, to the insidious attack of malaria, then given off in greatest abundance from the soil. In such localities, the afternoon should be selected; the men should be fortified by a good meal, and at least 3 or 4 grains of quinine, and an evening meal of which hot coffee should be a part should await them at the end of the march. The camping ground should be selected with care; should be in the driest available spot, not near ravines or any watercourses, and if possible, to windward of marshes, or any other obvious source of malaria.

The rules regarding drinking water already given, should be observed with more than ordinary strictness. The tents should be closed on the windward side, but kept open to leeward at night. Until the malaria-tainted district is traversed, halting days should be dispensed with. The tents should invariably be supplied with tarpaulin to spread on the ground, and Officers should see that the men have their blankets to protect them from the chill night and early morning air, which, charged with malaria, would otherwise certainly bring on fever, or dysentery, or both.

Officers can, without difficulty, carry with them their gauze curtains, which they should use at night. The mechanical filtration to which the air is thus subjected is certainly, to some extent, a protection from malaria. When serving in China, I carried my own in the folds of my blanket, and invariably used them, even when sleeping in the open air in calm weather, thus securing, not only the advantage above hinted at, but protection from the attacks of insects—the well-known murderers of sleep in such regions. When with the Army of Exercise,

as it was called, assembled at Agra to coerce the Rajah of Gwalior, I well remember the surprise universally felt in camp on the arrival of the late General Sir Thomas Valiant, who, with his aide-de-camp, had traversed in safety the pestilential jungles which intervene between the Bombay frontier and central India. They owed their exemption from fever to double gauze blinds, kept closely drawn night and day, with which their travelling palankeens were furnished.

The length of marches in India is, on ordinary occasions—that is for the routine of the service—regulated by the Quartermaster-General's department, in communication with the Commissariat, who arrange with the District Civil Officers for the needful supplies. The march should average about ten miles, and on ordinary occasions should not exceed twelve. Sometimes, to escape camping in an infected or unhealthy locality, it may extend to fourteen miles. It is always, however, open to the Officer in command, on the advice of the Medical Officer in charge, on good and sufficient reasons by him shown, to modify the length of the march or change the camping ground, as circumstances may demand. Troops, under the guidance of Officers experienced in tropical service, have, however, when well fed and otherwise cared for, accomplished as much as thirty miles a day, and that for several days. This was sometimes done during the mutiny in Bengal; but the limit of human endurance is soon reached, if such a strain is kept up for many days. The 52nd regiment accomplished forty-two miles in twenty hours, part of the distance in the sun, marching ten miles more next morning, and engaging the mutineers at the end of it. Dr. Parkes, who records this fact, is careful to add, "that the "men were dressed in light and suitable clothing." Under the old tight-fitting uniform of heavy red "shoddy," I believe such a feat would have been impossible, without dropping half the strength by the way.

I have already said that night marches, from any point of view, are not advisable. All the French combatant and Medical Officers of Algerian experience are unanimous against them, save for good military reasons, to which every other consideration must give way. The practice of dividing the day's march into two, with a mid-day's halt, is not to be commended. It is unpopular with soldiers, who infinitely prefer being called on to make some extra exertion to finish the day's work. In India, the practice occasions much additional labour on those whose business it is to pitch and strike the tents. It is, moreover, prejudicial to the beasts of burden, interfering with their proper time for food and rest, and it soon tells on their health and condition.

Pace.

On ordinary occasions, if the end of the march is accomplished by 8.30 or 9.0 A.M., the troops need not be *en route* before 4.30. The marching pace is regulated by order in all armies. Nevertheless, I have often heard old soldiers on the line of march say, that the walking pace of the Adjutant's horse had a good deal to do with it. Halts at the usual distances are, in the tropics, of paramount importance. To such an audience, it is unnecessary to say that a regiment will march faster than a brigade, a brigade than a division, a division than an army. Yet, in practice, forgetfulness of this well-known fact often leads to unnecessary exposure of the men. When the halt, which lasts from ten to fifteen minutes, is sounded from the front, it should be repeated rapidly to the rear; if this be not done, the troops in the rear halt just as the march is beginning again at the front. They are thus either deprived of their rest, or the continuity of the column of march is broken while they get it.

During these refreshment halts men may sit, but should on no account be allowed to lie down. This rule should be stringently enforced, when marching in the sun. During the French campaigns, so many men perished from sun-stroke while so doing, that Marshal Bugeaud published an order forbidding it. The reason, I suppose, is this:—A thermometer placed *on* the ground, in the sun in India, will mark 160° F., two feet *from* the ground it will stand 40° lower—an enormous difference. It makes a great difference whether the column marches in close or open order. So dangerous is the former, that the medical authorities in India long ago brought it to the notice of the highest military authority, and, except under a real military necessity, no experienced Commander would ever subject his men to the distress and danger inseparable from it in hot climates. Marshal Ney, indeed, declares it to be unsafe anywhere. I need not occupy your time by enforcing the necessity for personal cleanliness. It is of the greatest importance everywhere to see that men, young soldiers in particular, do not become footsore.* Non-commissioned Officers should be instructed to see to this important point, and by careful inspection to be sure that the under-clothing of the men is properly washed and well aired, more particularly on halt days, which should be allowed at least every fourth day, besides Sunday. If the families of soldiers follow their regiments, advantage should be taken of halt days to see that the country carts in which they travel and carry their luggage are unpacked, and their contents freely exposed to the air. Without this precaution, I have known them to become as unwholesome as some of the lodging-houses in our crowded cities.

Dysentery.

Dysentery has, time out of mind, been the scourge of armies. With

* The lecturer here showed a pair of shoes, and remarked—I hold in my hands a pair of shoes that I daresay would provoke the contemptuous laughter of a London bootmaker. Few of us would like to walk down Bond-street with them, and the Guards would object to parade in them for guard-mounting at St. James's. Nevertheless, they enabled an Officer to make the journey between Simla and the Thibet frontier twice over, without the wearer being foot-sore. They have been used also in pursuit of the mountain ibex, and have given a secure footing in places where the happy possessor of a pair of London-made boots, in a similar position, would be hurled from the line of eternal snow into an abyss 10,000 feet below. The "uppers" are made, you will observe, of the woven hair of the mountain goat, the soles of the untanned hide of the ibex, and sewn on to an elastic cushion of the wool of the mountain sheep. Notwithstanding the hard service they have seen, they are still as good as new. This is the shoe worn by the whole of the inhabitants of the Khunawur district, where a foot-sore man is never seen, and where a London chiropodist would starve.

good hygienic arrangements it ought to be a rare disease in modern times in well-regulated camps. Army surgeons of the present day are well instructed in the means of prevention, both in moving and standing camps. The measures already detailed all act in this direction. The grounds used for camping along the great lines of military communication should be kept with scrupulous care, and the severest sanitary police discipline should be enforced by every regiment using them, otherwise a privy-atmosphere, of all things most dangerous to health, will surround the place. The latrines for both men and followers should be carefully attended to, disinfected, and filled up as soon as the troops leave the place. It must be kept in mind that the excretions of dysenteric and cholera patients are active means of propagating both diseases, and no pains should be spared to prevent the camping grounds being soiled by them. Want of care in this particular in past times was a fruitful source of mortality. To be brief, cleanliness of place and person, temperance, good food, and good water, are the chief means of prevention; while marching in India, soldiers must sleep on the ground, but the tents should, I repeat, always be floored with good tarpaulin to prevent dampness, and, where possible, clean straw should be added, and the bodies of the sleeping soldiers, not overcrowded in their tents, should be protected from the chilly night wind.

What is called the cholera-belt should be worn by all soldiers. It is a great protection against the chilly air which invariably precedes the dawn, and which often brings on in young Officers and soldiers, severe abdominal pains, often followed by diarrhœa. The modern treatment of tropical dysentery is highly successful. The mortality among those treated by it is considerably less than one-half of what it was within my own recollection; but to be successful, this treatment must be early, and all Officers should give their cordial support to the Medical Staff in enforcing early application for aid on the first symptoms declaring themselves; and should impress on the men the disastrous consequences of concealment, and vain efforts to quench their sufferings by a recourse to such stimulants as they can command.

Sunstroke.

The next danger to be guarded against is sunstroke. Military reasons sometimes compel troops to march in the sun. It is to be hoped the day is passed for parades in heavy marching order in the hottest part of a hot tropical day, such as are to be read of in our Indian annals, with results that, little as they were thought of then, would in the present day raise a storm of indignant remonstrance against the cruel pedantry of those who ordered them.

I have elsewhere shown that men will bear a high temperature in the open air with comparative impunity, provided, 1st, it is not too long continued; 2nd, that the dress be reasonably adapted to the temperature and work to be done; and 3rd, that the free movements of the chest be not interfered with. Sportsmen in India know this well. It is impossible to exaggerate the importance of dress and accoutrements, not alone in India but wherever troops have to make long marches in the sun. On the 6th of July, 1760, towards the close of the seven years' war, Frederick the Great marched from Kloster Marienstern to the Spree, to reach Silesia, if possible, before the Austrian Field-Marshal, Daun. The soldiers were dressed after the rigid Prussian method of that day, which I take to have very closely resembled, in all its important details, the equipment we have just discarded, which in fact was a copy of the Prussian system. Mr. Carlyle, deriving his facts mostly from the German military historian Archenholtz, gives a terrible description of this march: "The windless day grows hotter "and hotter; the roads are of loose sand, full of jungles and impedi- "ments. This was such a march for heat and difficulty as the king "never had before. . . . . . The soldier, for his own health's sake, is "strictly forbidden to drink; but as the burning day rose higher, in the "sweltering close march, thirst grew irresistible. Crossing any of these "brooks, the soldiers pounce down, irrepressible, whole ranks of them, "lift water clean or dirty; drink it greedily from the brim of the "hat. Sergeants may wag their tongues and their cudgels at discre- "tion; showers of strokes, says Archenholtz, Sergeants going like "threshers on the poor men, though the upper Officers had a touch "of mercy, and affected not to see this disobedience to the Sergeants "'and their cudgels,' which was punishable with death. War is not "an over-fond mother, but a sufficiently Spartan one, to her sons. "There dropt down, in the march that day, 105 Prussian men who "never rose again. And as to intercepting Daun by such velocity, Daun "too is on the march; gone to Görlitz, at almost a faster pace, if at "a far heavier—like a cart-horse on gallop; faring still worse in the "heat, '200 of Daun's men died on the road this day, and 300 more "men were invalided for life.'"

On the 8th July, 1853, a body of men, 1,200 strong, marched from Beverloo to Hasselt. They started at eight in the morning. Only 500 reached Hasselt in the evening, 19 perished *en route*, and a great number, in a state of furious delirium, were taken into hospital.

The 43rd Regiment, during the mutiny of the Bengal Sepoys, marched from Bangalore in the Deccan to Calpee in central India, a distance, by the route taken, considerably exceeding 1,100 miles. With the exception of a few brief halts by the way of a few days at a time, the march was made continuously, a great part of it during the hottest part of the year; the men being exposed to a very high temperature by night as well as by day.

Dr. Barclay, the surgeon of the regiment, while in a valley at the foot of the Bisramgunge Ghat, observed the thermometer at 118° F., in the largest tents during the day, 127° in the smallest, and on one occasion he observed it at 105° at midnight. This terrible temperature and prolonged exertion, told with fearful effect on the men: long before they reached Calpee, they were reduced to the last extremity of weakness. When at the foot of the pass just named, cases of insolation were brought to the hospital tents at every hour of the day and night, and although a large proportion of them were recovered by prompt treatment, two Officers and eleven men died in one night and were buried under one tree in the neighbourhood of the camp. I could

multiply examples of the terrible power of the sun on soldiers in the field; the above must suffice. Examples of these gathered from the medico-military and naval annals of our own and other countries, I have given in the article "Sun-Stroke," in Russell Reynold's System of Medicine. But I cannot miss the opportunity of warning those inexperienced in tropical service, of the great danger of crowding soldiers in barracks, tents, or even ships at sea, in hot climates; direct exposure to the sun's rays is not the only way in which high temperature kills; it is often quite as fatal in the close ill-ventilated and crowded barrack dormitory, tent, or the main deck of a ship, as under the rays of a vertical sun. This suggests the question whether it would not be safer in such circumstances to dispense with tents altogether, and make the men sleep on the ground, or on such raised beds as they can extemporise from the materials at hand. No one can be more impressed than I am with the great danger under such circumstances as we are considering, and indeed any circumstances, of causing men to breathe the foul air of a crowded and ill-ventilated tent, and as the least of two evils I would sanction a bivouac in the open air rather than expose them to it. At the same time I must add, that so far as my experience goes, chiefly gained in India, it is opposed to the general practice, and in localities notoriously malarious, it is I am sure unsafe. I must only note here, in passing, a curious peculiarity in the behaviour of Frenchmen when under the influence of high temperature; viz., a disposition to commit suicide, seamen by throwing themselves into the sea, soldiers with their arms. In one of Bugeaud's marches in the province of Oran, 11 men destroyed themselves, 200 on the same march suffering from insolation. The thermometer taken alone, does not always indicate the danger. There are other facts not as yet very well understood, such as the nature of the soil on the line of march, whether or not it be covered with vegetation, the hygrometric condition of the air, its electric tension, and the state of health of those exposed. I have already sufficiently adverted to the effects of dress and accoutrements, the weights the soldier has to carry and the mode of carrying them.

What then are the precautions to be observed to minimize as far as may be, the dangers above indicated? They are briefly, loose and light dress, protection to head, neck, and spine, and, let me add, the abdomen also. I am informed by one of Dr. Livingstone's companions in his African travels, that they were all as solicitous to protect this region of their persons from the heat radiated from the soil, as their heads from the direct rays of the sun. For this purpose they used waist belts made of bunting, *white*, when they had it.* Anatomists and physiologists, remembering the position of the great plexus of the sympathetic

* The lecturer here remarked on the necessity of making that part of the cover of the soldier's cap, which protects the nape of his neck, not of one, but of many folds of white cotton cloth, which should come lower down on the shoulders than it usually does. He also produced a waist-cloth or Kummerbund, of the finest Rampoor shawl cloth, 30 feet in length, so light and flexible as not to incommode the wearer, and yet to give perfect protection to the abdomen. He also pointed out the universal use of this among the natives of India.

system of nerves, will understand the *rationale* of this precaution. Marches of moderate length, in open order and with frequent halts, the men being allowed to sit, but, for the reason already given, not to lie down. Personal cleanliness, an abundant supply of the best water procurable, for drinking and douching purposes, good food, and tea or coffee, instead of spirits, for refreshment. On one of the last occasions when Canton was occupied by British troops, there was an alarm at noon day, and the troops had to turn out. An Officer in command of a battery, thinking to do his men a kindness and to "fortify them" against what was before them, opened the canteen and gave each man a glass of spirits before starting; that battery had more cases of sun-stroke than all the rest of the force put together. Is it then advisable to drink water when exposed to the sun? With a good intention no doubt, the Great Frederick forbade this indulgence to his men, and we have seen what came of it. All sportsmen know that if they once begin to drink water, on the moor for example, obeying the first craving for it, they must go on so doing all day. If they resist, the inclination passes away, and they go on without suffering until they reach the luncheon basket by the side of a cool spring. This, however, is a different case from that of the laden soldier toiling in the ranks along a dusty road, half choked with dust, and sweating profusely. Water is then a necessity, and men, like the hart "heated in the chase," "pant" for it. The blood is every moment becoming heated, and but for the cooling effect of the enormous evaporation from the skin, would soon become super-heated, with effects fatal to the centres of nervous energy and power. It is parting also with its watery constituents, and nature cries aloud for its renewal. To withhold it under such circumstances is as stupid as it is cruel. It will surprise those who have no experience in such matters, that in sun-stroke the temperature of the human body will sometimes reach 110° F., that is within 3° of a temperature at which the albuminoid constituents of the muscular system coagulate, and late researches have shown that the sudden failure of the heart's action in some forms of sunstroke may be due to this very occurrence. This will explain why the modern treatment of insolation is mainly based on the rapid reduction of temperature.

Cholera is our next subject. During the greater part of my service in India, the belief prevailing in high quarters was, that cholera was like the wind "blowing where it listeth;" that nothing was known or could be known as to its origin, its movement, its propagation; it was felt to be a frightful evil, one that as it could not be cured, was to be endured. So long as this state of mind continued, measures of defence or precaution were deemed as futile as an attempt to get to the back of the north wind. If cholera was known to prevail along the route about to be traversed by troops moving both ways in the course of the usual reliefs, that was not considered a sufficient reason for interfering with the routine of the service. One regiment was sent on the track of an infected one (already carrying the disease from village to village along its route), occupying the same camping ground, soiled with the poisonous discharges from the persons of the sick. The whole atmosphere was tainted with the stench of the bodies of the wretched followers,

always furnishing the largest number of victims, torn from their shallow graves by obscene beasts of prey; but enough of this past, fruitful in scenes of horror on which I seek not to dwell. This was pre-eminently the pre-sanitary age. There is enough of mystery about cholera still; its exact cause we do not know, it may be we shall never know it. It may in the future, as it has in the past, elude all the most refined methods an advanced science can bring to the enquiry. For some years past many ardent minds have sought to look into this mystery in vain. Two young men in particular, singularly gifted with the philosophic spirit, and armed with all the means science can supply, were set apart for this honorable but dangerous service by the Professors of the Army Medical School, with the approval of the Home and India Governments; Drs. Douglas Cunningham and Lewis have laboured in this cause, and although their labours have not been unfruitful, and are still full of promise, nature has not yet been forced to yield her secret to the persistent enquiries of these young philosophers. For all this, we do not despair; and even if we are destined never to see the veil withdrawn that hides the mystery from our eyes, we believe that in time we shall learn how to restrain the ravages of this disease within narrow limits, if not to stamp it out altogether. We now know with some exactness its birth place, or, in the language of Dr. Bryden, an eager labourer in this field of enquiry "its endemic "area," whence it starts on its "tours of invasion." The laws governing its movements are being patiently examined, the means by which it is propagated from man to man, and from one congregation to another, are being sifted and recorded, and although on such points there is much conflict of opinion, I am confident the truth will appear at last "with healing on its wings." Already the enquiry has not been unfruitful in important results. Four times in the course of last year did cholera effect a landing on our shores, in London, Liverpool and Southampton, from foreign lands where it widely prevailed, and on every occasion the energetic efforts of the local sanitary authorities stamped it out before it could establish itself in its old haunts, and carry death to thousands of our countrymen.

To make intelligible the precautionary measures I am about briefly to give, I repeat here what I have elsewhere written. From the carefully observed and recorded histories, not of one, but of many epidemics of cholera, not in India only, but in every country yet invaded by the disease, I believe that human locomotion is the means of its extension from one distant place to another; in other words, as Dr. Netten Radcliff has expressed it, "Cholera does not travel, but is "carried;" while air and water are the main agents of its diffusion in the vicinity of a place into which it has been brought, aided often by the agency of infected clothing, bedding, or whatever has been contaminated by the excretions of those affected by the disease. Let this most pregnant fact, well insisted on by Simon, be kept ever in mind, viz., that where cholera is epidemic in any place, persons who are suffering from the epidemic influence, though, perhaps, with only the slightest degree of diarrhœa, may, if they migrate, be the means of conveying to other places an infection of indefinite severity. That the "quality of infectiveness" is in the matters which the patient discharges, that if these matters undisinfected are permitted to mingle with the contents of drains or cesspools, the very effluvia from them may infect; finally that if the cholera contagion from the above or any like sources, gains access to wells or other sources of drinking water, it will infect large volumes of the fluid. With regard to infected clothing here is a well-authenticated fact. Towards the close of the last epidemic of cholera in Malta, a woman in attendance on a soldier's wife affected with the disease, purloined and secreted an article of under-clothing worn by the sick person; weeks after the death of the woman, and after the disappearance of the disease from the island, this unhappy creature put on the stolen garment, without washing or disinfecting it, caught the disease and died. In like manner washerwomen who have had to wash the linen of infected persons without previous disinfection, have thus caught the disease.

It was long one of the "mysteries" of cholera, that it often localised itself in a particular house, a particular block of barrack buildings, one side of a street, and so on. The "mystery" is frequently explained by a careful inspection, disclosing local sanitary defects, a tainted water supply, and in some exceptional instances, even tainted food. I well remember one block of barrack buildings at Arcot, in the Madras Presidency, a very cholera-haunted station. It was on a much lower level than the main body of the buildings. To one division of this block in particular the disease, so soon as it appeared in the station, returned with the regularity of the swallow. At last, the floor of this pest-house was dug up, and a drain, choked with frightful accumulations, was discovered, the existence and direction of which had been forgotten. The barracks were built in the days of Clive, when Arcot was a place of importance, and, in their construction, every principle of sanitation had been violated—in nothing more than in the direction of the drains, driven as we have seen through the very centre of a dormitory. Bearing the above facts in mind, let me urge, first, that troops should not be marched into an infected locality, or tainted district. By way of illustration, take an historical example "written for "our learning," what is known as the Mhow Case. A detachment of artillery, with women and children, was ordered to march from that station to Poonah. It was reported to the General commanding the division that cholera prevailed on the route, and delay was urged on this ground. It, unfortunately, happened that this Officer, on a previous occasion for a like good reason, had delayed a movement of troops, for which he received a rebuke from head-quarters. Unwilling to expose himself to another, he allowed the detachment to march, which in due time entered the "tainted district." All the world knows what followed. A shocking mortality among men, women, children, and followers. The time had gone by when such untoward events could pass without notice. A great outcry arose all over India. It reached this country. The facts were commented on by the press and discussed in Parliament, and after an acrimonious correspondence between the General and the authorities, he was deprived of his command.

2nd. When cholera attacks in cantonments or on the line of march,

change of locality is a point of primary importance. Flight out of the tainted place is not left to anyone's discretion; it is now a standing order in India The Shakesperian maxim, "stand not on the order of "your going, but go at once," should be the rule of conduct; go, ere the men get tainted; go, before they become depressed and panic-struck, by the rapidity with which the disease carries off its victims. The move should be made to the driest soil, where cholera victims have not been —where, as Dr. Parkes puts it, "it is pure, impermeable, and un- "contaminated."

3rd. It is advised, when overtaken by cholera on the line of march, to move at right angles to the line of the prevailing wind. The plan may be tried—it sounds very reasonable—and if it be true that cholera germs or dust are carried to great distances by the wind, it ought to be effectual. Knowing however, as I well do, that cholera takes little account of the wind, finding its way, as I believe, by human means, not much hastened by a favourable, or much delayed by a foul wind, I do not personally think much of the measure. Others, however, whose opinion is deserving of respect, think differently.

4th. If a tainted village be on the way, avoid it; and, above all, if a body of tainted troops be approaching, it must not only be avoided, but the ground they have encamped on, being highly dangerous, must not be even approached.

5th. If a river be in front, cross it quickly. Do not linger on its banks, for the disease evinces a dispositon to cling to rivers, which is probably only another way of expressing the fact that it follows the course of human intercourse.

6th. Need I repeat once more all that I have said about jealous watchfulness over the sources of water supply, and the necessity of the careful purification of it? To the next and last point I attach the greatest importance, viz., frequent inspection of the troops, at least three times a day, by Medical Officers, to pick the men out in the first stages of the premonitory diarrhœa. The eye of the experienced physician will detect at a glance the tainted man, before he has a suspicion that anything but a painless diarrhœa affects him. This is the stage when treatment avails; check this at the outset, and the man is saved.

It is needless to repeat once more, that attention to the conservancy and disinfection of latrines is more necessary in this than in all other diseases which may attack troops in camps or on the line of march.

Yellow fever is the next and last subject to be briefly noticed. This terrible disease has a *habitat* of its own, viz., the shores of the Gulf of Mexico, and the northern and eastern shores of South America, and the islands of the Caribbean Sea. From this, its home, its "endemic "area," it has often been imported into other regions with destructive effect, but has never established itself in any of them as an endemic disease. Unlike cholera, which can live and thrive at St. Petersburg as well as in Calcutta, yellow fever loves a hot climate; there is much evidence to show that it has never established itself in any climate where the average temperature is below 72° F., and the late Dr. McWilliam, of the Royal Navy, one of our highest authorities on the subject, has shown that it is driven from the coast of inter-tropical Mexico between the months of November and March, when the mean temperature does not exceed 71° F. Humboldt was of opinion that yellow fever cannot exist at an elevation of 3,000 feet above the level of the sea. But the truth is that it has three times been imported into the mountain military station of Newcastle, in Jamaica, where, however, I must add, a most efficient *nidus* had been prepared for it by faulty sanitary arrangements. Again, cholera destroys men of all races with perfect impartiality. From some peculiarity in the organization of the negro race, they enjoy a certain degree of protection from yellow fever. Our Army records show this incontestably; the mortality among the black troops is as nothing compared to the whites from this cause. I have called your attention to the fact that cholera often operates in a limited area or "tainted district." One of the most fortunate circumstances connected with yellow fever is, that this is, in a much higher degree, one of its distinctive peculiarities, and I invite attention to it as of the highest practical importance to military men, as on it is based the chief measure of precaution. I have not time to give a brief summary of the evidence on this point, but from the earliest examples with which I am acquainted, down to that of the Lisbon epidemic, the different invasions of the terrible outbreak at Buenos Ayres, and that of Shrieveport in the United States, the disease has evinced no disposition to extend the area of its operations beyond the tainted district. The lesson this teaches us all is that in flight we must seek safety for those committed to our charge. At Buenos Ayres, safety was found a few miles outside the city; it was the same at Lisbon, and at Shrieveport; and Blair of British Guiana, who has written one of the best treaties on the disease, has recorded the same fact.

Whatever be the exact cause of this pestilence, which is as yet as obscure as that of cholera, one fact of primary importance stands out clear as noon day. It is emphatically a child of dirt; or, if this be going too far towards its filiation, an atmosphere of dirt is that which it loves and affects, and within which it confines itself. So long as New Orleans was an uncleanly city, yellow fever was an annual visitor. Whatever we in this country may think of General Butler, however little most of us would like to live under his rule, he did one thing for New Orleans, he vigorously enforced sanitary laws, and for nine years that city has enjoyed an exemption from the disease, a thing unknown in its previous history. Most of us know, by hearsay at all events, that Lisbon is not famous for that which is said to be near of kin to Godliness; Buenos Ayres, when at last, notwithstanding its attractive name, yellow fever was imported into it, was nothing but a network of enormous cesspools. The streets were covered with swill and offal. The water of the river was so affected by the fluids that drained into it, that fish died and were thrown upon the banks. The people drank the water, and met the same fate; Shrieveport was much in the same condition; and when yellow fever entered, a New Orleans physician

declared, that all who were seized with it dropped off like sheep seized with the rot.

Surely I need not point the moral?

Yellow fever is a disease with which our naval brethren have more to do than we have, now that so few troops are serving in its *habitat*. Naval Commanders and Surgeons know that when boarded by this unwelcome visitor, there is but one course to pursue, viz., to shape one for higher latitudes; and the sooner this is done, the better for the safety of the crew. In one word, by sea or land we must seek for safety in timely flight. This is a case in which discretion is certainly better than valour.

And now to conclude. It will be seen that I have not so much sought to lay down hard and fast rules; to say, "do this," and "don't "do that," as to establish principles from which precautionary measures flow as their corollaries. In other words, within the narrow limits, of necessity assigned to me, I have given you, in merest outline, it is true, a sketch of the natural history of the diseases which assail us in tropical climates, in the belief that this is the true way when addressing educated men to teach them how to meet and disarm them. This is not the ordinary vestryman's view of sanitation, and let me add, of those who act as if they deemed the conciliation of vestrymen of more consequence than national health. To such, given any unsanitary condition, and it is, in their opinion, "the toss of a half-penny," whether the outcome be small-pox or "fever," under which term they lump up half-a-dozen diseases specifically different in their cause, their symptoms, their anatomical lesions, their portability, their treatment, and mortality—cholera, or any other item in Pandora's box.

I am thankful for the progress we have made, I am hopeful of conquests yet to be achieved by preventive medicine at home, abroad, by sea and land; but I cannot withhold the expression of my belief that until the vestryman's "view" of sanitation ceases to influence the minds of those who aspire to direct public opinion and to guide legislation on this subject, the cause of what our continental neighbours aptly call "State Medicine," and with it all that belongs to the health of fleets and armies, will not take the place in the administration of affairs, its importance in relation to the happiness and well-being of our country, demands.

The CHAIRMAN: We have listened to a very interesting lecture upon a very important subject, and one which involves not only medical but military points. As the Sanitary Schoolmaster has been abroad so long, not only in private life but also in the Army, perhaps some officers or gentlemen whom I see present may be disposed to offer some remarks upon the points contained in the lecture.

Captain LUARD, R.E.: There are one or two points in the lecture that, with your permission, sir, I will comment upon. I think the most remarkable point was with reference to the height above the sea at which camping stations and garrisons should be placed, and this bears more especially on our position at the present time on the Gold Coast. We have been maintaining garrisons all along the Coast in positions which we know are not sanitary; but the probabilities are that, in future, stations could be selected on that Coast where troops could remain without any chance—or at least with much less chance—of their suffering from the terrible climate. We know that in the district of Akropong there are hills and uplands varying from

1,000 to 1,500 feet in elevation. The probabilities are that, if the troops were concentrated in that part, they would still be able to maintain a military control over the whole Coast. There is nothing, probably, from which soldiers suffer more than from drought, and anything which would tend to preserve them from thirst during campaigns and during marches is of the utmost importance. The lecturer commented on a beverage which he strongly recommended to troops, and that was coffee. Now some years ago I was hunting chamois in a very hot season of the year, and it was a most important thing to ascertain what was best to drink. We tried coffee and tea and cocoa; and my friends and I were unanimously of opinion that cocoa was far superior in enabling us to resist thirst to anything else. The use of spirits was entirely, as I understood, tabooed by the lecturer, but I would ask whether a very slight modicum of spirits mixed with the cocoa or coffee would be hurtful to the troops. My impression has been that although raw spirits are undoubtedly very bad for men, injuring the coats of the stomach, yet, mixed with soup or coffee, they are not deleterious in their effects, and are occasionally beneficial.

Sir William Codrington: There is one matter with regard to the clothing of troops. As long ago as 1842 I think, the Government gave to every soldier in Canada his fur cap and his mocassins at a cost of £3 to the country as an addition to his kit.

Dr. Maclean: What I had particularly in view was this, my colleague, Mr. Longmore, professor of Military Surgery at Netley, who served with the 19th Regiment in India, has often told me—in fact it is now in print—that he took the trouble to weigh the clothing sent after the regiment to Calcutta, which arrived in the dog-days to be served out to the men; he found that it was actually heavier than the clothing which had been issued to his own regiment whilst serving in Canada. Of course I did not allude to the external clothing superadded to that, but merely to the ordinary dress. In the case of the 19th Regiment, that certainly was so—the clothing served out in Calcutta, weighed more than that which had been issued to the same regiment in Canada.

Sir William Codrington: I imagined that you mentioned there was no change in the dress in Canada.

Dr. Maclean: I was referring to the ordinary uniform, not to great coats and such like additions.

Mr. G. W. Cockburn: If not intruding on the meeting, I would support what the lecturer said about the unadvisability of commencing to drink in hot climates, and how well I know the truth of his assertion that every true sportsman knows the danger of commencing to drink, in hot climates. I think we may learn a great deal from the natives of those countries; and I can also speak from experience, having kept the fast of Ramazan with a certain Mussulman regiment in India, who urged the fact that they were keeping the fast, against doing any work. I accordingly kept the fast myself with them, so that I might say "I am keeping the "fast myself, so we will go along together." The fast was kept from the first dawn of day until sunset; and the abstinence from drink was much more difficult to bear in the hot weather than the fasting from food. No Mussulman, as soon as the sun sets, thinks of quenching his thirst by taking a drink first; but he takes a small piece of salt and eats it, and he always takes a bite of food of some sort. The necessity of doing this should be always urged on our troops, whenever they halt, viz., to eat a little before they drink, as then the drinking will not bring on that fearful thirst, which, even the purest spring-water in the Himalayas will do, if you once commence to drink. If you commence to drink very early in the day, you will have raging thirst all the rest of the day; but if you resist that temptation to drink and take a small mouthful of food first and then drink afterwards, the effect is very different. I learned this very notably on a certain long march in a region I have no doubt well known to the lecturer, to the top of the hill near Simla. I was very anxious to get there in a very short time; and, before starting, an old lady had told me that ginger-bread nuts were a great thing to keep down thirst, and insisted on my putting some in my pocket. I laughed at the old lady's story and did not believe in it at all. The following day we had to start at two o'clock in the morning. I got nothing to drink; and marching in the month of May, although in the hills, is extremely hot work in the sun. I had a bottle of cold tea, which I would not touch myself, because if the men had seen me doing it they would have said that I was drinking and they were not, and would have made that an excuse for any further advance. I was very nearly dead with thirst at one time, when I thought of these ginger-bread nuts. I put a small piece of one of them into my mouth; I found to my astonishment that I went on with perfect ease afterwards. This is an old woman's recipe, but it is a very good one; and if the soldiers were furnished with ginger-bread nuts or a biscuit on these long marches and told to eat a small piece of that before they drank, I will guarantee from my experience, that drinking would not have the same effect of bringing on a raging thirst.

Mr. Rawlinson, C.B., C.E.: I hope I shall not be obtruding myself upon this meeting, this being a medical question, for I can only speak upon it from an engineering point of view; but I may, however, speak with some experience, seeing that I have been one of the Inspectors of the Board of Health since its formation in 1848, and that I had the honour of being appointed engineer to the Sanitary Commission sent out to the Crimea (1855). With regard to provision to be made for armies on the march, I am not going to occupy your time with any story of my own about that. I would simply supplement some of the lecturer's remarks with regard to the care that is necessary; and I will state briefly some regulations that I found neglected in the Crimea. I am speaking in the presence of Sir William Codrington, and I simply wish to explain certain regulations which I considered necessary, but which were neglected. The water supply of the camp at the front was obtained from natural springs and from ruined wells. The natural springs at the beginning of the second summer were in a muddy condition. There had been no attempt made to store the flow for 24 hours. The men drew water indiscriminately as they could get it. There was no regularity in the order of drawing, but each man drew as he went to the spring, the result being that the water was muddy from morning till night. It was the same with the wells. They were also drawn from indiscriminately from morning till night. The water slopped over the bank, went back again, and so contaminated the water. It did seem to me that it was so easy to remedy that state of things that in future it ought never to exist; as that whenever an army occupied a country, even for a brief space, the first thing to be done should be to put a guard upon the sources of water supply, and that the drawing of the water should not be done by the men individually but by orderlies told off for this purpose, and that some simple tank expedient should be adopted to economise the water for 24 hours. With regard to the watering for the cavalry camp, there were some 12,000 horses, and there were rows of watering troughs erected for the horses to water from—ten or twenty in a row; the water was run into the top trough, and then fed into the next, and into the next, and so on, the result being that before the water got half way down, the horses coming to the lower troughs would not drink it. This might have been obviated by a very simple expedient, for a small trough-spout or pipe might have been carried down in a line with the row of troughs with a small feed into each trough which would then have given an independent supply without its passing through any second trough.

With regard to the huts sent out to the Crimea, the roofs were covered with patent felt. Unfortunately for the soldiers, felt being waterproof was also air-proof, and no adequate provision had been made for ventilation. That was, however, sought to be remedied in different ways by the different medical officers of the different divisions; but I do not think any of the plans were entirely successful. The remedy that we recommended (and which was carried out) was to cut a slit in the roof, and then to cover it with a louvre-board raised about an inch above. If in the huts sent out to Africa the same form of roof has been continued, and that remedy has not been provided for giving ventilation, those huts may afford shelter to the men, but they will, at the same time, breed fever. So much was that the case, that some huts in the Crimea were emptied, as every man went down with fever when they were kept at the full charge of 25 men to each hut. With regard to cholera and what may cause cholera that is a question I am not going to enter into, excepting so far as to state that it has been my fate to examine almost every seat of cholera in this country, and whatever may be the cause of cholera, as the lecturer has remarked, it cannot be said (independently) "to travel," or "to jump," or progress in other similar ways described in many, even medical, reports, such as "passing mountains," "running up rivers," and "marching over plains." It requires human intercourse. It follows the human being; it is attached to him; but there may also be something else besides the human being to cause cholera. After investigating one site of cholera after another in this country, and thinking "Now I have found something about it; now I know something about it," I was driven from every post—one after another—and had to come to the conclusion at last that I really knew nothing about it, except that it had an affinity for dirt. There was the instructive case of the town of Alnwick. The medical officer there jotted down upon a map every case of cholera and of cholera death, and in looking over the map and examining the ground I found that cholera had fastened upon the site where the back land drained into and through the basement; where the houses built upon the slope had the fall away from them, they were exempt. At the backs of the houses were great heaps of ordure and refuse, and the sub-soil becoming tainted beneath the basement, the atmosphere of the interior had become contaminated with foul vapour. As to cholera crossing a river, the lecturer has explained that there was a large traffic of human beings on the one side and little or none upon the other. I remember a French commission inquiring into the cause of cholera, and it came to the conclusion that cholera did not prevail upon the granites. I said, "Have you much population in France upon the granites?" "No." "Then, how can it prevail there?" I said. One of the most severe cases we had in England was upon granite. It was at Megavissy, in Cornwall, where one-tenth of the inhabitants died in a month; so that stratification has little to do with cholera. With regard to clothing conveying cholera, and with regard to the notion of woollen garments being specially impregnated with virus, let me tell the lecturer one fact. At the time I was Chairman of the Rivers Commission I was holding an inquiry in Yorkshire where the manufacture of shoddy was first perfected. I had before me medical men who remembered the introduction of shoddy, which is old woollen garments, gathered from every dirty quarter of the globe—Egypt, Poland, &c., to the extent, that year, of 35,000 tons of shoddy, and principally into that district. I said, "Have you disease when you break open these bales and handle these woollen rags?" "Not one single case." I said, "Are you quite sure?" "Not a single instance within our knowledge." There was an experiment upon a gigantic scale, whether or not the virus, or whatever it may be that impregnates woollen clothing, for I am not going to say that a woollen garment taken from the back of a cholera patient and immediately put in contact with another, may not carry the disease, but whether length of time or ferment destroys the virus, and how long it takes to do so, is really a question well worth inquiring into. Inquiry has been made with regard to small-pox and linen rags, and the commission found that there was only one small paper manufactory where small-pox had broken out, and there the commissioners could by no means fasten the outbreak upon the linen rags.

With regard to water and cholera, I know something about the water supply of India. Having the honour to serve upon the Army Sanitary Committee, it is my fate to glance over the reports from every part of India, and that cholera should prevail in India, that fever should be rife in India, and disease in excess, need not astonish any person who will take the pains to look at those reports. Anything more abominable, more horrible, than the water supply of India generally cannot by any possibility be conceived. Many of the wells are so tainted by the water filtering in from the tainted sub-soil as to be utterly unfit for any form of use. And again, the Hindoo has a ready facility of committing suicide, and in one of the provinces it was found that in one year some 1,700 bodies had been taken out of wells and tanks used by the inhabitants of that district. Attention is now turned to it, and analyses have been made by hundreds, I may almost say by thousands, and means are being taken to improve the water-supply of India, and as that improvement takes place, I have not a doubt but that the mortality will be reduced. I entirely agree with the lecturer as regards the use of spirits, and I am delighted beyond measure to hear him denounce any use of spirits as a ration for soldiers in the field. I am fully satisfied that doing away with the use of spirits both for our Army and Navy (other than as a medicine), will be one of the greatest improvements.

Sir W. Codrington: I may mention that it was in times of great difficulty that the Sanitary Commission came out to the Crimea. There was the difficulty

of getting up huts, the difficulty of getting provisions, and the difficulty of getting water. I think that these things have not been quite considered in the statement that has been made to-night by Mr. Rawlinson. (Mr. Rawlinson: I did not wish to cast any censure.) I do not mean that at all.

Mr. Rawlinson: I only say, if I had to do with an Army in the field, a well or other source of water should never be left to be indiscriminately drawn from, as was the case in the Crimea; there ought not to be a single case of it in future.

Dr. Maclean: I have really very little to say in reply in addition to what I have already said. I believe I am quite at one with the gentleman who has just addressed us on so many points connected with sanitary matters in India, and more particularly with what he has so forcibly stated with regard to the water supply there. I did not go into all the details, but I am thoroughly acquainted with the truth of the facts that he has just stated, more particularly what he referred to just now with regard to the enormous number of suicides, particularly of women, in the wells and tanks of India. In the place where I myself did duty upwards of eleven years when I was attached to the Residency at Hyderabad in the Deccan, in the wells of the immediate vicinity of that great city, suicides took place in the way described by Mr. Rawlinson at the rate of three or four a night and frequently more. I would wish also to observe with regard to what was said about the non-introduction of cholera by shoddy that the instance I gave of the disease having been transmitted from one person to another, was exactly such a case as Mr. Rawlinson allowed might possibly be an exceptional one. This garment had not only been used by a person sick, but was tainted in the way in which you might naturally expect, and it had not been exposed to the air until it was again used and in that way we can very well understand that the germs of cholera or whatever you may choose to call them may have retained their vitality.

I should merely like to add that the blanket that you see before you, formed the side walls of a tent used by the Officer whom I have previously mentioned. The tent was in use for upwards of ten years, in very unhealthy localities, in the deep valleys of the Himalayas. The blanket was found to be capable of resisting any amount of rain, and, when exposed to the severest tempests, the tent was perfectly dry, and—what was noticed as a thing of very great importance—it also acted as a mechanical filter to the air; and the gentleman and his wife, who inhabited it for many years, never suffered from malaria. It is a notable fact that the people who live in the district I have mentioned, when they are obliged to sleep in malarious regions, invariably use a sort of mask made of the same material, though somewhat finer; having been taught by experience, the immense importance of filtering the air and thereby protecting themselves.

The Chairman: I am sure you will allow me to return your thanks to Dr. Maclean for his very interesting lecture, in which he has laid down maxims that may act as guides for the future. A more able or more philosophic lecture we could not have had, and I have great pleasure in conveying your thanks to Dr. Maclean.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

THE

CHEMICAL THEORY OF CONTAGIUM

COMPARED WITH THE

CORPUSCULAR THEORY;

With special reference to the Action of Disinfectants.

BY

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THE
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Mr. President and Gentlemen,—

The subject which I have the honour to bring before you, is one full of deep interest, involving, as it does, some of the most subtle and controverted questions of our day; and while I claim for it an importance second to none in the long *rôle* of subjects connected with Sanitary Science, I crave your indulgence for a short time while I bring some points, perhaps hitherto untouched, to your notice; and, with your assistance, I hope I shall be enabled to throw some light—however faint the glimmer may be—on our present knowledge of this most abstruse subject.

We shall regard contagia as substances which must come into contact with the organism if they are to affect it. By infection will be understood the power of being propagated through the inhalation of air tainted by the perspiration or breath of the affected person; and by the term disinfectant, is meant a destructive agent—that is, a substance that will prevent infectious diseases from spreading, by destroying their specific poisons. I propose, then, firstly, to give a short *resumé* of the views held in relation to the spore theory of disease; and, secondly, to see how far these theories bear close investigation, and the conclusions drawn from them.

Dr. Beale, in the year 1870, promulgated his views of the intimate nature of contagia, and submitted that the active properties in vaccine lymph lay in transparent particles of extreme minuteness, which he terms bioplasm, born in and only growing in the body. These particles are living, but do not assume any special form; they are not microzymes, or any vegetable life. "I am justified," he says, "in advancing the doctrine that the germs originate in man's organism, and that they have descended from the normal bioplasm of his body." They consist of a peculiar kind of living matter, the smallest particle of which, when supplied with proper pabulum, will grow and multiply. They can, in fact, be only identified by their effects. The contagium virus is then living and growing matter, the particles not being directly descended, but they have resulted from the multiplication of particles from without, which are capable of growing and multiplying in the blood, while it is not improbable that a few of the contagious disease germs actually acquire their virulent properties after they have left the organism in which they have been developed, and while they remain immersed in a media containing the proper elements of their nutrition and further development. They are extremely minute, and can exist under many different conditions. In connection with this statement, it is worthy of remark that Dr. Beale asserts that when once living matter has actually become ice, its life is for ever destroyed, and it is incapable of being revivified or revitalised. Now lymph was frozen, by means of solid carbonic acid, to a temperature of—116 deg. Fahr., and after this intense cold it was found to be unaffected. Under what conditions, then, can it retain its vitality?

The theory of Hallier utilising the laws of alternate generation and of digenesis in the reproduction of certain cryptogamic vegetations, is an endeavour to establish the dictum that "all virulent agents are nothing more than an allotropic condition of various mucedines or moulds, which only arrive at their complete development outside the body; though in it they multiply in the form of exceedingly fine granules, designated micrococci." Every virulent malady has been, according to this idea, set down as depending upon the presence of a fungus, each epidemic owing its origin to a different fungus. His theory is plainly dependent on metamorphosis, otherwise it would not stand argument, and until further investigation

throws more light on the fungoid nature of contagium, I think we may fairly dismiss it without discussion. With reference to this, I may say, in passing, that in no subject is there more diversity of opinion than exists among mycologists, and those are not few who deny all alternation of generation among fungi, on which alone Hallier's theory is founded. Closely allied to Hallier's is the Bacteroid origin of disease, and whether we regard these minute forms as mere particles of protoplasm, or a series of steps in the ontogenesis of a specific form, or with Cohn, who is inclined, from their resemblance to Alga Crenothrix, to class them with Oscillatorians, or with Lister, who believes that he has demonstrated the origin of Bacteria from a Fungus, a species of *Dematium*; their presence is sufficient to urge us to persevere in further investigations, and to endeavour to learn something definite of the character and growth of these minute organisms.

A modification of this theory is that Bacteria, naturally harmless in themselves, derive poisonous properties by feeding on morbid food, and thus become the carriers of specific contagium. The history of these minute forms has been studied with much care, and the observations of Pasteur are worthy of notice in passing. He is of opinion that some of the infusorial ferments, among which are the Bacteridia, develop only in oxygen, while another class, namely, *vibrios*, undergo their transformation where the gas is absent. Different changes are brought about by different germs; the butyric acid fermentation is due to a *vibrio*, the alcoholic to a *torula*, etc., etc.

The results of the most recent experiments on this subject that I am aware of are those recorded by MM. Downes and Blunt on "The Influence of Light on the development of Bacteria." They state that "light is not essential for the development of Bacteria;" that, in fact, it is inimical to their production, and that, under favourable conditions, it may prevent their development, while, under less favourable conditions, it may not prevent, but only retard. They further state that those conditions which tend to neutralize the action of light are the same which are known to favour processes of fermentation and putrefaction.

Passing on to more recent investigations, we gain fresh information from that distinguished veterinarian of the Lyons School, Dr. Chauveau, whose researches have been confirmed by Dr. Burdon Saunderson, and with extreme care have again been submitted to trial by Drs. Braidwood and Vacher. Chauveau tells us, and a study of his experiments will well repay perusal, that so far as vaccine lymph is concerned, the contagium consisted of minute particles, suspended in the contagium liquid; in short, that it is the particles, and not the soluble constituents of vaccine on which its activity depends.

By dilution of the lymph, Chauveau was enabled to separate, by subsidence, minute particles, called leucocytes, and he ascertained that the serum without them was just as virulent as when loaded with them. Thus he eliminated the presence of leucocytes as being the active germs, and, after most painstaking investigations, he demonstrated that the elementary granules of the pure serum never subsided and passed through every filter. The separation of plasma from particles could only, therefore, be effected by diffusion. I need not follow the successive steps of his investigations, which are fully recorded elsewhere, and shall only quote his conclusions, which are briefly as follows:

1. The vaccinal serosity is not virulent, and the activity resides in the solid granule, in all, or only in part, in these elementary organisms.

ed/ 2. In dilut~~ing~~ vaccine, the number of abortive punctures was always greater the weaker the solution, a result he attributed to the particles of vaccine being separated, and only now and then finding their way to the point of the instrument used for inoculating.

Messrs. Braidwood and Vacher tell us that we possess the strongest indirect proof that the contagium of the virus of vaccine consists of transparent particles, neither soluble in water nor in watery liquid, and not capable, without losing its properties, of assuming the form of vapour; that the

density of these particles was somewhat greater than the liquid surrounding them, as indicated by their tendency to subside. Chauveau further ascertained that in sheep-pox, water maintained in contact with the virus acquired no infective properties, which was directly the reverse with the water mixed with the virus, thus proving the particulate nature of the contagium.

In what manner are these particles produced? Do they spring from like bodies, or are they generated *de novo?* Are they animal or vegetable substance, or are they of the nature of ferments? How do they comport themselves under varying conditions? Such are the questions which perplex men of the most profound thought, at the present time.

Again, we have the physical theory of which Dr. Richardson is the exponent. He explains the non-vital nature of contagium by asserting that certain organic animal poisons exert their deleterious action by setting at liberty the oxygen of the blood in undue quantity, being themselves decomposed in the process.

In his paper on the experimental study of disinfectants, Dr. Baxter has given us much valuable information. Still he appears to me to start his argument with premises of a very questionable nature when he tells us that the infective principle is neither soluble nor diffusible, and therefore neither can it be volatile. Assuming this, it follows, he states, that all distinction between contagium and infection must cease. The one is communicable by direct contact, the other at a distance, and may be transferred as a solid, as a liquid, or a gas.

Again, we find Dr. Baxter experimenting on the virus of infective inflammation; but, may I ask, what proof have we that the lymph of infective inflammation is of the nature of germs? Is it not much more reasonable to suppose that it is simply fibrinous exudation, which, after coagulation, has acquired poisonous properties, and the physical and chemical characters ascribed to it by Dr. Baxter an afterchange, not indeed, by Dr. Baxter's own account, of a very marked character, for "few or no rod-like bacteria were observed.

and none of the organisms exhibited movements of translation."

Time will not permit me to refer to the interesting experiments of Tyndall or Bastean, the former holding the germ theory, the latter what may be termed the chemical theory; that is, that, as a result of fermentative change, gases are given off, and with these other soluble products mix imperceptibly with the changing and quickening mother-liquid, in all parts of which certain insoluble products also make their appearance, and reveal themselves to us as specks of protoplasm, that is, of living matter, and speedily assume the well-known forms of one or other variety of Bacteria.

These insoluble products, says Dr. Bastean, serve to bridge the gulf between dead and living matter, and thereby afford a long-sought-for illustration from chemical to so-called vital combinations.

It has been, I think, assumed by far the greater number of pathologists, and by Dr. Baxter in particular, that specific contagium, so far from being of an extremely delicate and subtle nature, really consists in solid particles, which, in vaccine lymph, according to Dr. Burdon Saunderson, are the twenty thousandth of an inch in diameter. But, may I ask, what proof have we that it cannot exist in any other form, or that the material of these very particles did not circulate in the blood of the living body in a dissolved state, and as such were capable of being thrown off by transpiration with other products? Assuming this, what becomes of Dr. Baxter's corollary, that the contagium is not volatile? and to admit the possibility of this would to some extent account for the communicability of smallpox before the development of the eruption, which ought to be the fruiting time, if, as many suppose, the particles in question are the minute spores of a specific fungus, and upon this theory the etiology of many diseases is explained, with more than ordinary positiveness. The unstable character of the blood never seems to have been considered (and this is not alone confined to the blood, for so all organic liquids when placed under a similar condition of rest), nor the tendency such substances invariably evince

to separate into a coagulum, or thicker portion, and a thinner stratum. Some late investigations by Dr. Creighton are important with reference to this subject. The *British Medical Journal* alludes to them thus:

"During the last year or two a great deal has been heard in England about a discovery by Dr. Klein of certain vegetable organisms which constitute the actual contagious element in sheep-pox and typhoid fever, these diseases being supposed to be caused by the introduction of specific spores into the system of a healthy individual, the course of the disease corresponding with their development. This pathological doctrine has sustained a sudden and fatal shock in consequence of certain investigations by Dr. Creighton, which are described in the proceedings of the Royal Society, Vol. xxv., No. 172. Dr. Creighton has found that, when fresh tissues are put in solutions of chromic acid, or alcohol, mucous or other albumenoid fluids coagulate in forms which simulate the appearance of the organisms which Dr. Klein believed he had discovered. Dr. Creighton remarks, that although Dr. Klein considered that he had before him in these preparations the various conditions of a fungus, to which he gave a specific name; and, although he professed to find the various conditions of spore, mycelium, and fructification, occurring in their natural sequence, to correspond with the regular advance of the pathological process, there is no doubt that the circumstantial account rests on erroneous observation and on defective evidence, and that the appearances found in the skin of a sheep are none other than those resulting from the coagulation of albumenoid fluids under particular circumstances."

To the theory of what may be termed solid particles, one does not object; nay, there is much, very much, to commend such views, borne out as they are by experimental facts; but why limit contagium so far, why can it exist in no other form, and why in the writings quoted should there be a tacit disavowal of all other forms in which it may exist? Carefully prepared diffusion has failed to rob those particles of their morbific power, and the same may be said of the altered fibrine of infective inflammation. The fact is, we have still to find out what contagium is, or really becomes, in its active state. We know how difficult it is to dissolve coagulated albumen or fibrine, and is not diffusion in a test tube very different from diffusion in the blood?

At least, we have to deal with one of two things in discussing the germ or spore theory of disease, viz.:

A. the organisms themselves, including, of course, their developmental history; and, B. the morbific products of their nutritive processes. The putrefactive odour is not due to the decomposition of vegetable or animal matter, as Cohn has proved, but is evolved by the active development of bacteria-termo in a solution of tartrate of ammonia without a particle of organic matter; the organisms are, therefore, at least in the case just given, the sole producers of the principles yielding that odour. Now, though we may be unable to trace any specific form of disease to this source, such principles may be regarded as equivalent to those products of other organisms which are presumed to be the producers of specific disease.

When once evolved, therefore, the morbific energy is resident in B., the products, rather than in A., the organisms themselves, and this may be absorbed though colloidal, when in an extreme state of dilution, and develope specific disease; and it is even possible to conceive that an agent capable of arresting the reproductive power of A. may at the same time exert little influence on B., and *vice versâ*.

Numerous experiments have shown that a certain relationship exists between the subjugation of Bacteria and the correction of the offensive odours surrounding them. Thus Chloralum destroyed the Bacteria in a beef infusion, while the smell was but little affected. Condy's fluid checked the odour in a great part, while the Bacteria preserved their activity; on the other hand, both were simultaneously subdued by Chloride of Lime. The fact appears to be, that we attribute too much to the coincident appearance or occurrence of microscopic forms with certain diseases, and to ignore purely chemical causes, though involving organic matter. Take, for example, a dissection wound; if the bad consequences

depended upon the introduction of such germs into the living body, one would say that more grave results would happen after sufficient time had elapsed to favour their further development. But this is notably not the fact, for we know that the virulence of the fluids is in proportion to their freshness, and, therefore, to their freedom from Bacteria. It would be absurd to refer the host of organic poisons with which we are acquainted to germs of any kind. The moistened fang of a rabid dog will carry death to many whom he attacks in his wanderings, yet we can detect no sensible alteration in the saliva to account for this. I need hardly refer to the experiments of Mr. Crooks, by which he obtained wonderful power over the cattle plague, by simply diffusing carbolic acid through the air—in one farm the disease altogether disappearing. He tells us in his report that, "Sound animals have been kept within eight feet of sick beasts without taking the plague when the air was kept constantly charged with carbolic acid."

Again, in whatever condition such a chemically active substance may be introduced into our bodies, whether as a solid, a liquid, or a gas, one of two things must happen. If it is of the nature of spores, ordinary reproduction, such as the formation of mycelium and subsequent fruiting, is the consequence, or they must operate dissolved in our bodies. Now, the former is certainly exceedingly unlikely, in that they differ from the fungi in the absence of all tendency to bud or branch: their only known mode of multiplication being by transverse cleavage, and the question occurs how far the change resulting from the latter may not be catalytic,—resolving the fluids and solids it encounters into its own likeness or nature without being changed itself.

The action of disinfectants on Schizomycetes is generally admitted to afford an index of the disinfecting power of the agent, and assuming that carbolic acid, for instance, has no effect on the solid particles, yet such may not be the case with the gaseous forms. Of course, only in proportion to the strength of vapour liberated is it of use.

Contagium liberated by transpiration and diffused in the atmosphere may possibly be corrected by carbolic acid. We base our argument on the effect the acid has on solid particles in a liquid medium, but we have no experimental proof of any results of this on the gaseous form.

But enough. Time will not permit me, sir, to enlarge on this subject, and in conclusion I would most earnestly impress on all not to be led away with results which to many appear so conclusive, but to persist in their endeavours to rid the atmosphere of infected places of their chemical poisons as well as the spore or germ—the offending particle, whatever it may be—accepting both as injurious and dangerous, calling in first nature's great means, namely, diffusion, dilution, and oxidation, and supplementing these by aerial disinfectants, the action of which, although imperfect, is certainly not to be condemned in the wholesale manner we have been accustomed of late to hear.

ON THE

INFLUENCE OF DIET, CLIMATE,

AND

LONG VOYAGES,

ON THE

HEALTH AND DISEASES OF SEAMEN

AS INDICATED BY THEIR WEIGHT, &c., &c.

BY

ALEXANDER RATTRAY, M.D.,

SURGEON R.N.

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THE

INFUENCE OF DIET, CLIMATE, AND LONG VOYAGES

ON THE

HEALTH AND DISEASES OF SEAMEN,

AS INDICATED BY THEIR WEIGHT:

BEING THE RESULTS OF EXPERIMENTS MADE IN 1865–6, ON THE CREW OF H.M.S. 'SALAMANDER;' WITH PRACTICAL DEDUCTIONS.

BY

ALEXANDER RATTRAY, M.D.

SURGEON R.N.

A.—*The various Agencies which affect the Health of Seamen.*

HEBERDEN tells us that "one of the first steps towards preserving the health of our fellow-creatures is to point out the sources from which diseases are apprehended," while Wilson, a recent and more strictly nautical authority, remarks that "high as is the present standard of health in Her Majesty's Navy, there is reason to anticipate that it may be raised still higher; and in a matter of such importance any observations which have that purpose in view will be not only inoffensive but acceptable." To follow the first of these indications and thus further the second, is the object of the present inquiry.

The great aim of the medicine of a former age was the *cure* of disease: its *prevention* is the characteristic effort of the present day. And nowhere should prophylactic measures hold so prominent a place as on shipboard, where disease, always inconvenient, often easily induced, and too frequently severe, is combated under the least favourable circumstances and at the greatest cost. Hence, while prudent sanitary suggestions should be the navàl surgeon's highest professional aspiration, as their success is his chief honour, prompt and judicious legislation in accordance therewith is the wisest policy of the State, as it is the most important boon that can be conferred on the sailor.

The success of various and especially dietetic reforms made about the close of last and beginning of the present century, to which we are indebted for the almost total extinction of scurvy and other severe maladies, then the bane of the service, as well as later innovations which have materially improved the healthiness of our ships of war, and the necessity for keeping pace with the rapid advance in this direction evident on shore, all incite to further improvements with a view to save much of the sickness and suffering still prevalent, and thus economise both men and money.

Hasty deduction might lead us to infer that in ordinary circumstances none ought to be healthier than sailors, subjected to so many influences of a long-recognised salutary tendency. Reflection and experience, however, soon dispel this illusion, and tend to show that, although there are certain peculiarities in their position and the life they lead that are eminently conducive to health and longevity, to counterbalance this there are others of an adverse kind, more or less constant and universal, which are prejudicial to the system of the seaman, and inimical to the sanitary condition of the service generally.

Among the advantageous influences, a liberal dietary, carefully enforced private and public hygiene, well-regulated physical, moral, and mental discipline, and freedom from petty cares are exactly the indications that would be pointed out as those best adapted for establishing the health of men closely massed in limited spaces and otherwise situated as sailors are. While the principal injurious agencies which tend to undermine the constitution and militate against the salubrity of seamen, include broken and deficient nocturnal rest, exposure to sudden and great climatic and meteorological vicissitudes, the respiration of impure air during sleep, unavoidable subjection to excessive solar or stoke-hole heat, and, lastly, the present system of dieting. On individual vigour depends much the issue of the struggle between these opposing forces. In a few the trial ~~of health~~ results in retained health and perhaps a lengthy life; but in the majority it sooner or later ends, it may be once and again, in disease; or if that is evaded, in debility, and ultimately the premature decay and old age so prevalent among mariners.

But there are two circumstances in which the former have the least and the latter the greatest effect, and the system of the sailor has most to contend with, viz., long voyages and tropical service. It is then, and especially when the two are combined, that health is most apt to be deteriorated and disease induced. And it is to a vitiated local or ship-atmosphere, broken rest, debilitating climates, and certain dietetic influences, that the slowly deteriorating vitality, the gradually augmenting proclivity to disease, the more serious ailments, and the increasing percentage of hospital, invaliding, and fatal cases, observable as the voyage or commission lengthens, are doubtless principally due. Nevertheless our etiological views with regard to many naval ailments, and especially tropical maladies (which undoubtedly arise from one or more of these sources), are still so vague as to lead to frequent false reasoning, and much injudicious meddling, both prophylactic and remedial. And this is much to be regretted, because precise physiological and pathological data can alone furnish safe guides to aid us both in defining our treatment of disease and basing efforts for its prevention.

Moreover, when we recollect that it is to the same agencies that the brief lives and much of the sickness and mortality among seamen under all circumstances are chiefly due, the necessity for attempting to assign

to each its proper share in the production of these effects must be still more apparent, lest we err in our efforts to counteract or cure them. The action of vitiated air and broken rest in producing the results in question is usually so slow and insidious that it is difficult to isolate their influence; but the speedier, more potent, and tangible effects of climate and diet aid us materially when we attempt to specialize their single or combined consequences. These consist of two classes of phenomena, the physiological and pathological, the former chiefly comprising various changes in the normal function or structure of different organs of the body within the limits of health, and the latter of the same deviations carried into the domain of disease. And as it is their influence on the salubrity rather than on the sickness of sailors we are to endeavour to elucidate, it is with the first that we have here principally to do; although so intimate is their mutual bearing, and so indefinite the line which separates normal and abnormal life, that in noticing this we are necessarily observing both, and shall find it impossible to make the study of either independent.

The more evident primary results of a sojourn in the torrid zone consist mainly in exaggerated or impaired function, which especially affects the nutritive and eliminatory systems, particularly the skin, liver, lungs, and kidneys; and are manifested by general lassitude of body and brain, a decrease in the respiratory movements, appetite, and urine, and augmented thirst, cutaneous exhalation, and flow of bile. But other important though less frequently noticed effects usually follow a passage through, or more prolonged stay in, the tropics, first among which is a decrease in the weight and strength. To what tissues or organs this is chiefly referable we may hereafter attempt to determine. But that it is a serious oversight to specially note the former obvious, and slight the latter less manifest, effects of climatic mutations, will appear when we consider that many physiological and pathological phenomena are identical in kind, and differ only in intensity, and that consequently a good knowledge of the former often furnishes the best criterion to guide us in the prevention or treatment of the latter, on the only safe, viz., a philosophical foundation.

The influence of different diet-systems on the human frame is perhaps ultimately as marked, though not so speedily manifested either in their minor or major forms, as those of climate. Their potency as morbific agents has been long recognised; but, as with the latter, their less observable results have hitherto been little attended to. But here also, variation in weight, either on the side of increase or decrease, is one of the most characteristic and easily noted sequelæ. As a general rule, health and weight have so intimate a relation that no better standard of the former, and certainly no simpler index of disease, whether arising from climatic or dietetic agencies, could be had than is furnished by their effect on the latter. Indeed, so much is this the case that a decrease in the one, if considerable and continued, may usually be deemed an almost infallible indication of some detriment or change in the other; and *vice versâ*, when the body maintains its usual bulk and vigour, we may fairly infer that individuals enjoy good health, and that their various organs and functions are normal. Hence this test is probably the best which could be chosen for showing the relative and combined effects both of the present naval dietary and of tropical service on the system of seamen, a subject not hitherto determined with the accuracy desirable in all medico-physiological inquiries. And as an index of graver results which often originate in the same influences, and as a guide for hygienic suggestions, necessarily most valuable and likely to be followed by the greatest success when founded on fact, this test cannot fail to possess more than merely professional interest and importance.

B.—*The influence of Diet, Climate, and Long Voyages on the Health of Seamen, as indicated by their Weight.*

The crew experimented on numbered 238, of whom 220, or eleven-twelfths, were under thirty-five years of age, *i.e.*, below the prime of life. They were thus favourable subjects, as they were in other respects suitably situated for an inquiry of this nature. Their original weight in England formed the basis for contrast with the various changes that occurred during the voyage of five months to, and subsequent stay of three years on, the east coast of Australia*.

The following Table shows the effect of a voyage of 7,600 miles from England to the Cape of Good Hope.

TABLE 1.

1st weighing . . January 9, 1864, Plymouth . . . . } 55 days.
2nd „ . . March 4, 1864, S. Atlantic, lat. 33° long. 21° W. }

Number of fresh-meat days . . 5	Number of days—
„ salt „ . . 50	in the tropics 34
„ lime-juice „ . . 11	in temperate regions 21

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	155	8	45 . . 1 to 13 lbs.	lbs. $3\frac{3}{5}$	103 . . 1 to 23 lbs.	lbs. $6\frac{42}{103}$

The two chief debilitating agencies against which the men had to contend during this period of fifty-five days were—the thirty-four days' tropical climate, and the fifty days' salt-meat diet†. And the result shows that of the entire crew there was a loss of flesh in 103, or two-thirds, to the average extent of $6\frac{2}{5}$ lbs. per man, the individual loss ranging from 1 to 23 lbs., and in forty-five, or about one-third, an average increase of 3, and range of 1 to 13 lbs., the latter occurring in men of strong inherent constitution, such as would readily fatten on any diet if sufficiently abundant, and even under circumstances usually

* Only an outline of these experiments has been given here.
† Except where specially mentioned, fresh-meat days imply the issue of succulent vegetables, and salt-meat days their absence.

inimical to health. A sick-list of two at the commencement of the experiment, and five at its close, corresponds to this. This marked result was not due to loss of appetite and a resulting decrease in the ingesta; for the food consumed per man during the first week averaged 1 lb. 13 oz. daily, and during the last week 2 lbs. 3 oz., *i.e.*, 6 oz. more.

The prosecution of the voyage, after a health-reviving stay of sixteen days at Simon's Bay, enabled us to continue the inquiry under different circumstances, viz., where one debilitating cause, climate, was in abeyance, while the other continued in full force.

TABLE 2.

1st weighing . . April 14, 1864, near Cape of Good Hope } 49 days.
2nd „ . . June 2, 1864, near Sydney . . . . }

Number of fresh-meat days . . 1	Number of days—
„ salt „ . . 48	in the tropics 0
„ lime-juice „ . . 39	in temperate latitudes . . 49

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	148	13	101 . . 1 to 19 lbs.	lbs. $4\frac{32}{101}$	34 . . 1 to 8 lbs.	lbs. $2\frac{1}{2}$

This shows the effect of a forty-nine days' voyage to Sydney along 41 S. lat., *i.e.* in a climate altogether temperate, and very like that of England, the chief depressing agent being forty-eight days' salt-meat diet. Lime juice was issued on thirty-nine days. In this instance also the results are very marked, though unlike the last, inasmuch as they are on the side of gain. For of the 148 men weighed, 101, or two-thirds, had increased in weight to an average of $4\frac{1}{3}$ lbs.; while thirty-four, or about one-fourth, had lost flesh to a smaller average and range. All the boys who had the strong vital resilience of youth in their favour gained in weight, as did the younger men, while the seniors and debilitated lost. The increase could have no connexion with an improved appetite and ingestion of food; for the average consumption at the end of the experiment was only seven drachms a man per day above what it was at the commencement, and thus too trivial to appreciably influence results. And it appeared as if the simple exit from the tropics had relieved the system from some antagonistic power, and enabled it to struggle with decided success to regain its normal standard of weight, and rebuild its wasting tissues even out of ill-adapted materials.

But, while the loss of weight in one-fourth of the men proves that the present sea-dietary cannot be considered innocuous, we must not, when we contrast the smaller loss, both individual and collective, in this than in the last experiment, be led to judge hastily of tropical climate, and consider it the only deleterious influence at work on long voyages. For, singly and unconjoined with other agencies, climate may, like diet, be comparatively mild in its results for such limited periods; and, possibly, it is only when climate and salt-meat diet are conjoined that they prove so potent.

TABLE 3.

1st weighing, Plymouth .. January 9, 1864 .... }
2nd „ Cape York .. August 10, 1864 .... } 230 days.

Number of fresh-meat days .. 74	Number of days—
„ salt „ .. 156	in the tropics 50
„ lime-juice „ .. 73	in temperate latitudes .. 180

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	119	9	34..1 to 19 lbs.	lbs. $5\frac{1}{2}$	76..1 to 23 lbs.	lbs. $6\frac{33}{76}$

Table 3rd shows the result of the whole voyage of 230 days from England to North-eastern Australia, where the tropics were entered for the second time. It will be seen that the majority lost flesh; and doubtless the same thing happens in all lengthy passages. So that a law might be laid down, the longer the period the more evident the effect on weight. The system cannot bear an unlimited strain; weight is first affected, and disease ultimately ensues, the sick-list increasing with the decreasing weight and vitality.

The following experiments were made while on the Australian station, and employed chiefly in making triannual trips from Sydney, situated in the temperate zone (latitude 34° S.), to Somerset, near Cape York, and well in the tropics (latitude $10\frac{1}{2}$° S.), a distance of 1700 miles in a nearly north and south direction along the north-east coast.

TABLE 4.

1st weighing .. June 2, 1864, Sydney .... }
2nd „ .. September 14, 1864, Denison, after a } 104 days.
trip to Cape York .... }

Number of fresh-meat days .. 53	Number of days—
„ salt „ .. 51	in the tropics 62
„ lime-juice „ .. 90	in temperate latitudes .. 42

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	120	6	6..2 to 8 lbs.	lbs. $3\frac{2}{3}$	108..1 to 24 lbs.	lbs. $6\frac{4}{9}$

Table 4th shows the effect of 104 days under three depressing agencies, viz., sixty-two days' tropical weather, fifty-one days' salt meat, and five weeks' severe subsolar work at Somerset. In this instance nine tenths of the crew lost flesh largely, a result which could not arise from a diminished appetite or a reduced supply of food, for the average consumption at the close of the experiment, when thus losing flesh daily, had increased by $3\frac{1}{4}$ oz. per man. Contrasted with the figures in Table 1st, in which only two of these adverse agencies operated, this shows how materially the third influenced the results; for then only two thirds lost weight, but in this case nine tenths of the crew. A diet which is nearly one half fresh, is thus not alone sufficient to counteract the effect of prolonged tropical exposure, and renders us still more inclined to believe that the great loss of weight in such circumstances is due, neither entirely to tropical weather, nor to salt meat alone, but to their combined influence, conjoined, perhaps, with other agencies of lesser note. The following experiment in which one debilitating agent, viz., climate, was nearly the only one at work, will decide whether or not it is so.

TABLE 5.

1st weighing .. February 10, 1867, off Cape Capricorn }
2nd „ .. April 12, 1867, Port Denison .... } 61 days.

Number of fresh meat days 25	Number of days on vegetables
„ salt „ 36	and soft bread 18
„ lime-juice „ 56	Number of days in the tropics .. 61
	„ temperate latitudes 0

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	86	4	34..1 to 14 lbs.	lbs. $3\frac{29}{34}$	48..1 to 13 lbs.	lbs. $4\frac{1}{24}$

Table 5th shows the effect of a trip to Cape York and back, lasting sixty-one days, all spent in the tropics, twenty-five being fresh-meat, fifty-six lime-juice, and eighteen fresh-vegetable and soft-bread days. Thus more than one half lost weight considerably, while a fewer number gained, and to a less extent. The beneficial influence of the fresh meat, succulent vegetables, and loaf-bread, is clearly shown in the case of the officers, of whom only four out of fourteen lost weight, the majority gaining flesh. So far as it goes, this proves that tropical climate of itself has a material influence in diminishing weight and impairing health. But to make the inquiry completely satisfactory, with a view to ascertain the uninfluenced effect of tropical climate, it would be necessary to keep the men on fresh meat and vegetables during the entire period, a combination of circumstances not easily met with on shipboard.

It now remains to show the effect on weight and health when all removable injurious agencies are withheld, and a ship's company is placed in every respect in circumstances conducive to health.

TABLE 6.

1st weighing, Sydney, June 23, 1865 .... }
2nd „ „ August 30, 1865 .... } 68 days.

Number of fresh-meat days ..56	Number of days—
„ salt „ ..12	in the tropics.......... 0
„ lime-juice „ .. 0	in temperate latitudes ..68

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	87	7	66..1 to 13 lbs.	lbs. $4\frac{11}{33}$	14..1 to 6 lbs.	lbs. $2\frac{2}{7}$

Table 6th illustrates the influence of a sixty-eight days' stay in Sydney Harbour, *i.e.*, in a healthy temperate climate, and on a fresh-meat and vegetable diet. No fewer than three fourths gained flesh considerably, while about one sixth lost slightly, which shows the beneficial effect on health of such a stay, and its agency not only in recruiting strength after tropical service, but enabling them to withstand the debilitating results of future trips to the tropics; and the figures may be instructively compared with those in the following Table, which points out how a twenty-eight days' stay at Somerset, *i.e.*, in a tropical climate, and on a diet chiefly salt (twenty-four days), affected the weight of the crew.

TABLE 7.

1st weighing, Somerset, October 9, 1865.... }
2nd „ „ November 6, 1865.. } 28 days.

Number of fresh-meat days .. 4	Number of days—
„ salt „ ..24	in the tropics..........28
„ lime-juice „ ..28	in temperate latitudes .. 0

	Number Weighed.	Weight not changed.	Number who have Gained in Weight, and Range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and Range of Loss.	Average Loss per Man.
TOTALS	92	8	8..1 to 10 lbs.	lbs. $3\frac{3}{4}$	76..1 to 12 lbs.	$4\frac{2}{19}$

Here, although the quantity of provisions taken up did not vary, the great majority lost weight materially; and it necessarily follows that a longer stay in either place, Sydney or Somerset, would have been succeeded by more apparent results. Thus these trips of two or three months each to the tropics invariably reduced the weight and weakened the crew generally, while the intervening sojourn in the temperate climate further south had an opposite and beneficial effect. The injurious influence of a prolonged stay in a warm region, if it needed any

further corroboration, is shown by the case of the marines stationed at Somerset, eleven of whom, taken at random, were found to have lost weight in every case, and to the high average of $11\frac{8}{11}$ lbs. each man.

As elsewhere, so in the tropics, the hot-rainy and dry-cool seasons may be regarded merely as modifications of climate, and the former looked at as tropical weather exaggerated, if we may so speak. The following Table contrasts the results of two voyages from Sydney to Somerset and back during these two different parts of the year, and shows how much more injurious is a wet than a dry equatorial atmosphere:—

TABLE 8.

To show the Effect of Season on Weight in the Tropics.

	Number weighed.	Weight not changed.	Number who have gained in Weight, and range of Gain.	Average Gain per Man.	Number who have Lost in Weight, and range of Loss.	Average Loss per Man.
				lbs.		lbs.
Rainy Season; N.W. Monsoon.	111	14	12..1 to 8 lbs.	3	85..1 to 20 lbs.	$7\frac{2}{85}$
Dry Season; S.E. Monsoon.	95	7	46..1 to 12 lbs.	$4\frac{8}{23}$	42..1 to 12 lbs.	$3\frac{8}{21}$

Thus, although the tropical weather and salt-meat diet caused a marked waste of tissue in both instances, a much larger proportion lost flesh, and that to a greater extent, in the wet season than in the dry, in which the numbers who lost and gained were nearly equal.

Having thus shown, first, that salt meat alone has a certain influence in diminishing weight and deteriorating health (Table 2), second, that tropical climate has a greater effect in reducing the strength and bulk of the body (Table 5), and third, that these results are materially augmented by combination (Tables 1, 3, and 4), the following contrast (Table 9) will indicate the relative effect of these various agencies:—

TABLE 9.

To show the relative and combined Effect of Salt Meat and Climate on Weight.

Reference.		Number weighed.	Percentage in which no change.	Percentage who have gained, and range of Gain.	Average Gain per Man.	Percentage who have lost, and range of Loss.	Average Loss per Man.
					lbs.		lbs.
Table 2	Salt-meat diet.	148	8·78	68·24..1 to 19 lbs.	4·28	23·0 ..1 to 8 lbs.	2·5
„ 5	Tropical Climate.	86	4·18	39·53..1 to 14 lbs.	3·85	55·81..1 to 13 lbs.	4·04
„ 1	Salt-meat and Tropical Climate combined.	155	5·16	29·03..1 to 13 lbs.	3·6	66·45..1 to 23 lbs.	6·80

Thus, when salt meat alone acted, the number who gained (68 per cent.) was considerably higher than under tropical climate (39 per cent.), and still more above what happened when they were combined (29 per cent.), while both the range and average gain decreased in a corresponding ratio. On the other hand, the percentage of those who lost weight, as well as the range and average decrease, were all in a minimum on salt-meat diet alone, greater under tropical climate, and greatest of all with both combined. These facts prove that the advantage is on the side of salt-meat diet, than which tropical climate is a more injurious agent, and that their malific results, if we take weight as an index, are very greatly augmented when both exert their force at one and the same time, the one probably serving to intensify the other. Salt meat may thus be regarded as the minor, and warm weather the major debilitating influence during long voyages and tropical service.

Again, the following Table will show clearly the relative influence of subjection to these various health-undermining agencies in diminishing weight :—

TABLE 10.

To Contrast the Effect of Various Influences on Weight.

Reference.	Gain or Loss in Weight.	Per-Centage.	Average per Man.
	Gain.		lbs.
Table 6 ..	Under no injurious influences	75·8	4·5
" 2 ..	" one " (salt-meat diet) ..	68·2	4·2
" 5 ..	" one " (tropical climate)	39·5	3·8
" 1 ..	" two " (salt meat and tropical climate) ..	29·0	3·6
" 4 ..	" three " (salt meat, tropical climate, hard work)	5·0	3·6
	Loss.		
Table 6 ..	Under no injurious influences	16·0	2·8
" 2 ..	" one " (salt-meat diet) ..	22·9	2·5
" 5 ..	" one " (tropical climate)	55·8	4·0
" 1 ..	" two " (salt meat and tropical climate) ..	66·4	6·8
" 4 ..	" three " (salt meat, tropical climate, hard work)	90·0	6·7

Thus, comparatively few increased in weight under three adverse influences (5 per cent.); when only two, viz. salt meat and tropical climate, acted, the number who gained was considerably greater (29 per cent.); while it was still larger under tropical climate alone (39 per cent.); still more so under salt meat (68 per cent.); and highest of all, when these were removed and the circumstances wholly salutary (75 per cent.); and the average gain in each case indicates a correspondingly

increasing ratio. On the other hand, the lower Table shows that both the number and average loss decreased in an exactly inverse ratio, being highest under three (90 per cent.), materially smaller under two (66 per cent.), slighter still under tropical climate alone (55 per cent.), less still under salt-meat diet (22 per cent.), and least of all under a combination of genial agencies (16 per cent.).

We shall hereafter see that the two most important of these act in producing this decrease in weight on and through the blood. What tissues are affected it would be difficult to determine ; but heat probably first causes a diminution of the fatty, and then of the muscular element ; while the influence of food is perhaps not very dissimilar. But these sequelæ nevertheless differ in this respect, that the primary result of tropical exposure is chiefly physical, and manifested by an alteration in the quantity of the solids and fluids ; while that of diet is not only the former, but also chemical and qualitative, and, while influencing their bulk, likewise, and perhaps principally, affects their composition.

C.—*The Effect of Diet, Climate, and Long Voyages on the Diseases of Seamen.*

These changes on the weight of seamen enable us in some measure to judge of the influence of the same agencies on their diseases ; indeed, the results in question may be regarded not more as a sign of failing health than as an index of incipient illness ; and the concurrent appearance and advance of loss of flesh and actual sickness under circumstances which are identical, viz., during long voyages and tropical service, seem to indicate that cause and effect have in both instances an intimate connection. We have only to prolong the period of exposure to either agency, or both combined, to cause the physiological decrease in weight to merge into more serious pathological phenomena ; and we shall presently see how great is the coincidence in both with regard to the circumstances attending their development. Diet and climate have for long been, and doubtless still are, two of the principal morbific agents against which the system of the sailor has to contend. However, we cannot now so easily define and isolate their effect in the production of disease as in former times, when graver excitants induced more serious sequelæ ; but we may readily infer their existence from the above enumerated less-marked, but still sufficiently obvious results on the physique.

Previous to the reforms suggested by Blane, diet was a notable source of sickness and mortality in Her Majesty's Navy. But though the diseases which resulted therefrom, of which scurvy was the chief, have materially decreased since their introduction, it must be admitted that they are not quite eradicated from the service, and that the improvements in question, though the best that could be devised for that day, were not thoroughly complete and satisfactory. The latest Statistical Report (1865) shows that fifteen cases of scurvy occurred during that year, while the returns for the past ten give an average of twenty-nine per annum. Doubtless we seldom if ever meet with the disease in the intense and unmodified form at one time prevalent, but usually in a milder shape. Nevertheless it is there, and appears inclined to linger; while in the merchant service it is more frequent and severe; and in the navies of some foreign Powers still more common; and in both, not unfrequently, so serious as to cripple their ships at sea. And no one will aver that diet, if not the sole, is at least the principal cause of this. But it is unquestionable that the loss of weight which occurred during the voyage from the Cape of Good Hope to Sydney (Table 2), which only required time to manifest itself more forcibly and widely among the crew, and ultimately become developed into actual disease, had also diet as its sole or at least principal source, as did the increasing sick-list towards the end of the period; results which the present favourite antiscorbutic, lime-juice, could not prevent. And though facts are cited by various writers to attempt to show that salt meat does not produce scorbutic ailments provided fresh vegetables are supplied, this appears drawing a rash conclusion; for doubtless were a salt-meat diet continued for a sufficiently lengthy period, the deleterious influence of the one would ultimately prevail over the prophylactic properties of the other, and scorbutic affections more or less marked ensue. Fresh vegetables have probably no power beyond warding off and lessening the injurious results of a prolonged salt-meat diet. Many experienced physicians believe that the beneficial effect of lime-juice as an antiscorbutic extends no further, and that it will not prove a complete preventive if the voyage extends beyond a certain period, even though we increase the quantity issued, as its influence on the system lessens. Dr. Bryson says, that "it will not prevent the evolution of this disease under the present diet system for an indefinite time, or retard it according to the presence or absence of other predisposing causes, for more than three, four, or perhaps six months." Various causes, especially an improved dietary and shortened cruises, prevent the development of the diathesis in the widespread and serious form it once assumed, and limit it to an occasional mild and solitary manifestation in Her Majesty's Navy; but still the elements of morbid action are evident; and are we not justified in believing that much of the disease which occurs during long voyages, especially towards their termination, has a dietetic origin and scorbutic alliance, like the co-existing decrease in weight; more particularly when the tropics are entered, and the injurious effects of diet are augmented by those of climate; and that for example, many of the phlegmons, abscesses, and asthenic inflammatory affections, so prevalent on shipboard as to incapacitate 300 men daily; and of the ulcers which sicken 240 daily, and invalide 64 yearly, as well as cutaneous affections and other minor ailments prevalent on shipboard, if not solely caused by the sea-dietary and tropical regimen, and essentially mildly scorbutic from a minor degree of blood-vitiation, are at least partly their result, and certainly both materially intensified and protracted thereby?*

Climate, too, has long been recognized as a fertile source of sickness among seamen. We are familiar with a class of ailments usually termed tropical; and maladies of this nature, both mild and serious, including hepatic and enteric ailments, fevers, and many other forms of disease, form no inconsiderable part of the naval surgeon's practice. But although modern hygienic innovations have materially diminished these both in

* These, and subsequent averages, are for a period of ten years, viz., 1856 to 1865, inclusive.

force and frequency, the naval medical returns will show that warm latitudes furnish a large proportion of the disease which still occurs in the service, both of the varieties strictly speaking climatic, and others not specially so. Also that the percentages of sick, hospital cases, invalids, and deaths are all highest, as a rule, in the warm regions, *e.g.*, the West Coast of Africa or Gulf of Mexico, and least in cold or cool ones, like England. And further, how these rise and fall as the station partakes most of the temperate or tropical character. Thus the "Coast," which is entirely sub-equatorial, is highly prolific of disease, and, according to the report for 1865, furnished 9·69 per cent. of invalids, and 5·77 of deaths, as in China, which is principally tropical, and sent 5·48 per cent. of invalids, and 2·12 of deaths; while chiefly temperate stations, like Australia, furnish fewer cases, viz., 2·68 per cent. of invalids, and 1·38 of deaths; and altogether cool ones, like the "Home," the least of all, viz., 2·16 per cent. of invalids, and 0·59 of deaths. So manifest is this, that if the percentage of sickness or mortality on any station is always above the average, we may conclude that it is in its tropical part this has arisen. And it may be laid down as a rule that stations are unhealthy in the direct ratio of their tropical to their extra-tropical area, the greater the former the higher the amount of disease. And to these facts the army returns and private experience closely correspond.

Nevertheless, though the preceding experiments go far to prove that climate alone is a source of decided physiological change closely bordering on disease, which would doubtless actually ensue under a longer continuance of the cause, a fact from which we may fairly infer that this agent, singly and unaided, often produces many serious ailments, there are good grounds for believing that, though perhaps the strongest, it is not the sole morbific agent in equatorial latitudes, and does not always, and perhaps not so often as commonly supposed, act alone, but in concert with others in producing marked results, either physiological or pathological. The inhalation of the impure air of the sleeping-deck, necessarily most unwholesome when the temperature is highest, is unquestionably a medium which materially intensifies the effect of tropical climate. But a contrast of Tables 5 and 1, as given in Table 9, the one showing the influence of a warm latitude, and the other that of climate and diet combined, proves how much the food issued to sailors at sea augments the loss of flesh and strength; from which we may safely conclude that it has an equally marked tendency to intensify the diseases which spring from the same origin. And of these two sources of sickness liable to be added to that of climate in the tropics, both introducing subtle poisons into the blood, the one by the lungs and the other by the stomach, the latter, or ship diet, is probably the more potent of the two in augmenting the malific tendencies of warm climates, and inducing the diseases so common and often so fatal there. Thus while it is certain that a salt-meat diet deteriorates health, there is also strong presumptive proof that it materially influences both the force and frequency of disease, especially when conjoined with a debilitating climate. And, having shown that it is both pathologically and practically erroneous, let us next consider whether or not it is theoretically and physiologically wrong.

Though man is in a limited sense and more than any other animal, cosmopolite, nature has not only alloted each race a suitable home, but made special provision in these for their ailment, and laid down certain laws for their guidance therein, which are never broken with impunity. And it is on his proper food and in his own zone that he enjoys the highest health. A material departure from either is certain to be followed, sooner or later, by disturbance of the system, if not disease. And if he must migrate, either to a higher or a lower latitude, he is most likely to avoid, or at least limit, both consequences by adopting native habits, and endeavouring to mould his pliant frame to altered circumstances. It is in this direction that we must look for an explanation of the real nature both of these pathological results and of the previously demonstrated changes in weight induced by dietetic and climatic causes, phenomena which are so intimately allied, both in class and origin, as to constitute one and the same series; and the solution of the origin of which is of even greater interest and higher importance than the mere decision of their existence, inasmuch as it may enable us to decide how far we make nature's dictates our guide, and follow this best of all instructors in framing our hygienic and especially our dietetic systems.

The climate best fitted for the Anglo-Saxon is that which lies above the 40th parallel of latitude in the northern, and the 30th in the southern hemisphere. It is that in which they have been born and reared, or one closely resembling it, which best suits our sailors. And when circumstances, over which they have usually no control, compel them to leave this and enter warmer or colder countries in either hemisphere, and particularly when doomed to serve in the former, with the peculiarities of which their frame appears less competent to contend, various functional and structural physiological deviations accrue in the event of the non-occurrence of acclimatization, a phenomenon of doubtful existence, which may ultimately and sometimes does very speedily end in the more marked departure from health which we term disease, the advent and character of which necessarily depend much on individual vigour and the intensity or length of exposure to the exciting agency. And although these phenomena are not usually so serious as would result were the residents in either extreme of heat or cold to exchange abodes, because the vicissitude it involves is less momentous and the vital resiliency of the dwellers in the intermediate zones great, they are still sufficiently severe. Ailments of a purely climatic origin, no doubt, form a considerable proportion of those tropical maladies from which our seamen suffer so seriously on certain stations; though, as the diseases of strangers sojourning in a foreign clime, these necessarily differ materially from, and are not only more serious and frequent, but also dissimilar in character from those which prevail among the aborigines breathing their native atmosphere.

On the other hand nature has no *universal* dietary, one adapted for all races and every clime. For while the system of the natives of the tropics is best sustained by vegetable, and, of the frigid zone, by animal food, in the intermediate region they require mixed animal and vegetable matter. Any departure therefrom is certain to be followed by more or less bodily detriment; so that if the inhabitant of any of the three, for example, the temperate, does not abandon the food so freely supplied in his allotted locality, but less plentifully elsewhere, on passing its confines, but adheres to his mixed diet on entering either tropical or arctic regions, instead of making it chiefly farinaceous in the one and principally fatty in the other, and thus continues to pour into the stomach more nitrogenous in the first case, and in the second less carbonaceous material

than the system needs, to form new tissue, reconstruct the old, and maintain heat, he introduces extraneous and unnecessary elements into the blood, the elimination of which throws a strain on various organs which they cannot always bear, and which is more than ever likely to cause the constitutional changes induced by climate alone to pass beyond the bounds of health. The adoption of a too rich and nourishing diet in warm latitudes, often dangerous in a cold country, is not only highly obnoxious in itself, but doubly so by tending greatly to increase the evil effects of climate; and it is usually to both that the sickness so prevalent there is due. This is doubtless the source of a still larger number of those ailments so common among seamen in many low latitudes, long and specially noted for their insalubrity. The longing which man often feels for succulent vegetables when subjected to unaccustomed heat, and the disinclination for animal food, are indications which ought not to be lightly treated; and instead of enforcing the continuance of the diet scale suited for temperate latitudes, when they approach the equator, we would preserve health better were we rather to adjust the ingesta to the genuine though necessarily not to the imaginary, wants of the system, and when entering a tropical region rigidly enjoin a tropical regimen.

The sustenance which nature thus liberally supplies mankind in every habitable region, and even in some which are barely so, is always found in the *fresh* and never in the *salt* state. The latter is not only an artificial form of food, but that which departs more than any other both in structure and chemical composition from the primitive character of what she provides; and, like all substitutes for original productions, it is not only faulty and inefficient as a life-sustainer, but injurious. If, therefore, in sending our vessels to sea in any latitude, but more especially in the tropics, we attempt to keep their crews in health (a more important indication towards preserving their efficiency than physical training) by giving them aliment which yields not only too much animal and fatty and too little vegetable matter, and the former in a condition which experience has long and amply proved to be unfit for the proper reconstruction of the ever-wasting fabric, even in temperate latitudes, and still more in warm ones, need we be surprised at the large percentage of sickness which prevails under the present diet-system, especially during tropical service, or the high ratio of hospital, invaliding, and fatal cases? Though climate and injudicious dieting are in themselves fruitful sources of disease, it is ailments which have a compound character, and are partly climatic and partly dietetic, which constitute by far the largest proportion of the affections peculiar to warm latitudes, and especially those from which sailors often suffer so severely. In our etiological inquiries we are too ready to refer disease, and especially tropical ailments, to extraneous and often obscure if not fanciful sources, while we overlook or contemn such as are simpler, more obvious, and closer at hand, and especially one of internal origin, viz., diet; and we are especially apt to ignore or despise the influence of salt meat as a debilitating medium, both on healthy and sick subjects. Food, though long, is not yet sufficiently, recognized as an active instrument in the causation of disease, as it also is in its cure and prevention. And climate, though an important morbific agent, both predisposing and exciting, especially in the tropics, gets far more blame than it really deserves, and is often reproached when other causes merit equal if not greater censure.

A brief chemico-physiological consideration of the former doubtfully injurious and latter decidedly deleterious effects of tropical climate and diet will also materially aid our investigation. In these agencies it is evident that seamen have two insidious foes that sicken and slay far more than the open enemies against which they have sometimes to contend. We already know well enough when and where they act; and if we can ascertain how they operate, and which of the many vulnerable points of the system they attack, it may enable us to direct our opposing or reparative efforts with some prospect of success, and thus realize for the sailor results which he cannot accomplish for himself.

The principal effect of the first and greatest of these, viz., excessive warmth on the system, long since pointed out by Copland, is chiefly to diminish the changes produced by respiration on the blood, from which there follows a long train of secondary phenomena. The carbon, imperfectly discharged by the lungs, accumulates in the blood, to be excreted either by the liver, skin, or intestinal canal. An exaggerated function in these organs and a compensating pulmonary decrease succeed. And so long as they sustain this revolution, health is enjoyed. But if impeded in action, the noxious elements which ought to be thus eliminated, necessarily augment and vitiate the all-important vital fluid, and ultimately both body and brain. It is to this that we largely if not principally owe the lessening weight, the daily weakening system, and sensibly failing health which befall a large majority of every ship's company; as well as the hepatic, intestinal, and febrile disorders which attack many; and the mortality which often saddens their comparatively limited stay in passing through or serving a commission in a tropical climate. And to this also is due the attenuated and enervated frames, modified constitution and temperament, frequent ailments, premature decay, brief lives, physically and mentally degenerate offspring, and ultimate extinction of race which result from the longer sojourn of more permanent European residents.

The diet which nature provides for the tropics is such as suits both the system and the clime. There the body needs no additional external or internal caloric as in arctic and to a certain extent in temperate regions. Nor does it require so much muscle-yielding material as the frame of the more active inhabitants of colder latitudes. Hence the carbonaceous and nitrogenous elements correspond to the limited demand, while the hydro-carbonaceous constituents are proportionately large. It is this diet which Europeans ought to adopt when they enter tropical regions, and which, with certain modifications to meet special requirements, is best adapted for our seamen when sent thither. And when we adhere to the scale originally constructed for their native latitude, instead of accommodating their regimen to altered circumstances, it is equivalent to throwing more muscle, fat, and alcohol* into the stomach, and carbon and nitrogen into the blood than the system is able to make use of, and the emunctories to eliminate, and chiefly the liver and kidneys on which the burden of discharging these principally falls; while we are withholding the additional vegetable matter which appears indispensable to preserve

* Theory suggests, and experience proves, that, in ordinary circumstances, alcohol in one of its worst forms, rum, is a pernicious adjunct of the present scale, and at least unnecessary if not prejudicial to health in temperate latitudes; while in the tropics it is not only needless, but highly injurious, both as a local irritant of viscera already over excited, and a vitiater of the blood otherwise overloaded with impurities.

the body in health, and that at a time when the system, revolutionized by a change of climate and habit, and struggling to mould its different organs and functions to new conditions, is little able to oppose any additional malific agency. To preserve health in the tropics we must consult climate as well as other physical conditions of life; and it is as necessary there to regulate the food and drink in accordance with the wants of the system, as it is to modify the clothing, exercise, &c. to the meteorology. Seamen doubtless need a certain amount of fleshy food in warm latitudes; but to give them the same quantity as in temperate climates is evidently against all physiological law. We err in providing a diet which consists so largely of meat for the tropics, when it ought to be one which is principally vegetable. True, the naval dietary contains vegetable matter, strictly so called, but of a highly nitrogenous nature, which not only does not supply the blood with material fit for a tropical climate, like the rice, yams, and other roots, fruits, grain, and vegetables commonly used for food by the natives, but, like the animal matter, yields so much of the muscle-yielding constituent as to redouble the danger arising from super-azotized blood. The evil effects of this obvious mistake on the weight we can only ascertain relatively, because it is impossible to separate them from those of climate, which acts in concert with it. But a contrast of the result of both combined, with that of the latter when it acts singly (Table 10), shows how materially an injurious diet will increase the loss of flesh which occurs in warm regions; and experience, both private and military, especially in India, testifies that not only is health preserved, but disease and mortality decreased, the more nearly the European conforms to indigenous diet, and the less closely he adheres to that which prudence should prompt him to discard on quitting temperate latitudes. And to this also, viz., the use of a too stimulating diet, and non-adoption of native usages, is doubtless due no inconsiderable share of the sickness so prevalent and disastrous along the tropic shores off which our cruisers coast or lie; where the overtaxed system, alternately excited or depressed by excessive heat and an extra-tropical dietary, is too apt, when thus obnoxious to disease, to succumb and fall a prey, if not to these alone, to the many other morbific agencies ready to attack the race, and especially the alien, when thus harassed, in climes which, as a rule, are sickly in proportion as they are sultry. As an excess of azote in the blood is often a prolific source of disease, so its non-elimination is also conducive to the development and propagation of many miasmatic maladies*.

But modern sea-dietaries add another element to those already pointed out as militating against the salubrity of seamen in warm latitudes. Long confinement to meat preserved in salt causes loss of weight, and ultimately serious sickness, even in cold climates; while in high temperatures both results undergo a decided increase; and in the production of these phenomena this agent acts in several ways, which it will be not more interesting than useful to consider.

By pickling, fresh meat loses at least one-eighth of its weight in the brine, which extracts much of its gravy, including gelatine, albumen, osmazome, water, phosphates, lactic acid, and other vital principles more or less essential for nutrition. Subsequent boiling still further deprives

* Copland, 'Dictionary of Medicine.'

it of these elements, and again reduces it in bulk by one-fourth*. While by both processes the fibrin which composes the muscular fibrillæ, and also their protecting gelatinous sheath or sarcolemma, are shrivelled, corrugated, and rendered hard and dry. And if we administer meat thus chemically and physically altered, as food, we give what strong, young, and healthy seamen may subsist and even fatten on for a time (Table 2), but which soon acts injuriously and causes the majority to lose weight, and, if continued, ultimately inflicts serious injury on all. Its salt and hard indigestible fibre, which the gastric, biliary, and other secretions necessary for digestion can with difficulty dissolve, is apt to act as an irritant on the stomach and alimentary canal, a sequel especially dangerous in tropical latitudes, where diseases of these viscera are often imminent. Deprived of its original juices, and containing little real nutriment, it is incapable in any latitude of furnishing sufficient pabulum, and more than all, of yielding the proper elements for sustaining the frame. While in the salt with which it is loaded we find not only a frequent mechanical cause of disease, but a troublesome cumulative blood-poison in all, but especially in low latitudes where the system has climate and warmth as well as diet to oppress and often overpower it. This has long been a fertile source of sickness, and still causes not only occasional true scurvy, but other ailments of decided scorbutic alliance already alluded to, as well as much of the dyspepsia, dysentery, and diarrhœa which now prevail in tropical regions, and occur most often in systems tainted by this cachexy from the prolonged use of salt meat and an extra-tropical regimen.

Besides acting directly as a morbific agent in all latitudes, especially in the tropics, where it is conjoined with a superfluously nitrogenous and carboniferous diet, salt meat is necessarily indirectly malific through the influence it has on nutrition and growth, particularly in those affected by the different constitutional diatheses now so wide-spread, especially the strumous, syphilitic, and rheumatic, that originate numerous diseases and complicate many more. If we feed men so affected, as many and perhaps the majority of sailors unquestionably are (and it is difficult to enter or keep them otherwise), on food of a debilitating and innutritious nature, and of itself a frequent source of the former condition, which so

* The following experiment will prove that this estimate is not excessive, and rather under than over the truth.

	Salt pork, 1½ years old.	Salt beef, 1½ year old.
	lbs. oz.	lbs. oz.
Original weight when taken from pickle cask	10 4	8 4
Weight after being cooked	6 1	5 8
Loss by boiling............	4 3	2 12
Percentage of loss............	40·85	33·33

Thus, in the case of the salt beef the decrease in weight was exactly one-third; and with the pork considerably greater, viz., two-fifths. Both were cooked in the ordinary way, and first soaked for two hours in fresh water, then boiled one hour and a half in the ship's coppers. Half a pound of fresh or preserved meat is fully equal in nourishing power to one pound of salt beef or pork as served out to seamen.

often aggravates the other two, instead of furnishing such as will yield matter for building up healthy tissues and aid the *vis medicatrix* in throwing off morbid germs; need we wonder that these and similar abnormal habits of body should sooner or later become developed into active disease? It is doubtless thus that the innumerable forms of scrofula are manifested, and especially phthisis, often so acute and speedily fatal in the tropics, from which alone no fewer than 306 men are invalided, and 112 die annually; thus, also, why primary syphilis and gonorrhœa are so tedious in their cure at sea, and syphilitic affections so frequent and intractable as to necessitate the annual invaliding of 74 men, and the excusing of 439 from duty daily; and thus, too, in great measure why rheumatism is so common and so severe as to result in the invaliding of 189 men yearly, and the daily incapacitating of 228. A system possessing a strong proclivity to, and ready at any moment to develope unhealthy action, with blood vitiated, either from hereditary taint or by cumulative poisons slowly introduced by the stomach, lungs, or skin, is little likely to keep in full health and vigour even in temperate latitudes, and far less in the tropics, by being fed on aliment which, instead of aiding, only opposes nutritive and reparative processes, and, so far from assisting nature to get rid of noxious matter, only adds a new source of detriment and disease. And it is also thus that so many men, weakened by injudicious dieting during lengthy voyages, fall a ready prey to the morbific agencies prevalent on foreign stations, especially tropical ones. By our own act we induce debilitated frames in those whom it is our interest to strengthen, and thus not only invite the attack of disease-generating media, and furnish them a suitable nidus, but render the system less able to resist their influence. And hence partly why ships on warm stations become more and more sickly; and why, on visiting infected or malarious districts, their crews succumb so readily to epidemic or other ailments, which otherwise would only attack their victims in a mitigated and comparatively innocuous form. Our care of health and attention to dieting are all the more necessary as the commission and stay in the tropics lengthen, and the progressively weakening system is daily becoming less able to withstand exciting or predisposing causes of disease, and requires vigilant nursing, and, above all, judicious feeding. Nor is it surprising that blood elaborated from such food as we now administer, and physically, chemically, and vitally changed, should prove inefficient to supply plastic material to reconstruct firm, sound, and healthy tissue, whether to replace the normal interstitial waste, restore the excessive loss caused by disease, or heal lesions of surface, as the cutaneous in ulcer, or the mucous in dysentery.

A study of the laws of disease, like that of the closely related rules of health, thus shows that the conditions which maintain the one and those which induce the other, are of the simplest character, and that nature, though a kind, is a stern nurse, and never fails to punish when she cannot prevent disregard of her dictates.

D.—*Practical application of the Inquiry.*

Physiological experiments are valuable in proportion as they aid us in obviating more important pathological phenomena. As the discovery of the source of disease is the first step towards its cure, so is it for its prevention and perhaps ultimate extinction. Now the preceding facts not only reveal the origin of much weakness and predisposition to sickness, but also indicate the means by which these and greater results that may subsequently ensue, can be obviated. Our endeavours to prevent or lessen the one should therefore be identical with those directed against the occurrence of the other. Diet and tropical climate are two malific instruments which doubtless originate a large proportion of the ailments, and cause much of the invaliding and mortality which still occur in the service. These effects accrue partly from the potency of the excitants, evidence of which has already been given, and partly from the numbers unavoidably exposed thereto.

Thus, with a navy of 50,000 men, we may safely aver that one-fourth, or 12,500, are constantly at sea, and subjected to a salt-meat dietary. And any map will show that of the eight foreign stations to which our ships are sent for commissions varying from two to five years, although only one, viz., the Coast of Africa, is wholly intertropical, no fewer than six are tropico-temperate and lie partly in both regions, while one, viz., the Mediterranean, is entirely in the temperate zone, like the "Home" station. The tropical cruizing-ground, which comprises the entire "Coast," and portions of the Pacific, Brazils, West Indies, Cape, East Indies, China, and Australian commands, is therefore extensive, and the number of men and vessels constantly employed thereon so considerable as to amount, if we include the variable "irregular" force, to about one-fourth of the whole. Thus, with a navy of 50,000 men, there are about 12,500 serving in warm latitudes, and subjected to the agencies so prevalent and potent there. Nor is this all; for few seamen escape foreign service, and the majority undergo it so repeatedly that we may safely estimate that two-thirds of every sailor's time is spent abroad, and at least one-half in sultry regions; and, in a series of years, few of the entire 50,000 avoid more or less and sometimes very prolonged exposure of this kind.

And the indication is obvious. To prevent an effect, discontinue its cause; to remedy a result, remove the agency which produced it. Long voyages and frequent change of climate are inseparable from the service; but we may easily obviate the evil consequences of the sea-dietary; and we already possess the means to make both of these frequently employed and powerful therapeutic and hygienic agents health-giving instead of health-impairing, and as salutary to sailors as they often prove to landsmen. Our ships of war must, and may always have, to serve in the tropics; and we cannot therefore help subjecting their crews to high temperatures and debilitating climates, nor can we yet tell how we may directly prevent the constitutional effects of heat, or counteract injurious climatic influences. Nevertheless we know that various hygienic expedients often enable us indirectly to oppose the one and materially lessen the other. And, aware as we are how much diet aggravates the evil effects of this unavoidable obnoxious agent, and also how greatly the former is itself to blame for much of the sickness which occurs in the service, it will be evident that, by removing the pernicious medium within our reach we shall not only avoid increasing, but tend to diminish, the potency of the less tangible one which lies beyond our power; and that a sanitary improvement in the food will not only completely banish malific dietetic sequelæ, but materially decrease climatic ones; the former

wholly preventible, the latter only partially so, and thus by one and the same reform do much to remedy the pernicious tendencies of both. The circumstances in which the system is least acted on and altered, whether as to weight or disease, are those in which it is most advantageously placed as to diet and climate in accordance with what nature suggests and prudence prescribes; and it should be our aim to place our sailors in this position when possible. Rectify and reframe the faulty regimen, make the diet correspond with the clime, and disease and death would materially decrease when most prevalent in Her Majesty's Navy, viz., during long voyages and tropical service. To have healthier, longer-lived men, and, as such, better seamen, we must feed them appropriately.

In all cases, both in preserving health and producing disease, diet acts in and through the blood; and if we would maintain the former condition and avoid the latter contingency, we have only to follow a safe rule applicable in all circumstances, viz., to regulate the ingesta so as to supply that fluid with plastic elements of such kind and quantity as will exactly counterbalance the continual drain which the various processes of animal and vegetable life in the human economy involve; and increase, diminish, or vary them so as to enable growth to equal waste of tissue. We must cease to consider it immaterial what sustenance we give large bodies of men like those which constitute the services, provided only we issue it in sufficient abundance. Nor does the great object in naval dieting consist solely in keeping our seamen alive. We must make their diet accord with the wants of the system, and in framing our dietaries, consider not only the quantity and quality of the food we give, but also its nature. We ought to administer such aliment as will furnish material to assist nature in converting the growing lads and young men who form the mass of our ships' companies into the athletes required to man our ships, and not only bring, but preserve them, in the highest possible state of physical efficiency wherever they are sent, and not only keep them in health, but have no tendency to induce disease *per se*, or develope or aid other malific agencies of either internal or external origin. Now, candid inquiry must decide that in all these essentials is the present naval dietary found wanting, with the exception of the fresh meat harbour-scale for temperate latitudes, which is not only ample but admirable in kind, as proved by its effects on weight and health (Table 6). But the same amount of animal food, and the limited supply of suitable vegetable matter in the tropics, is not only detrimental to health, but an all-powerful generator of disease, and auxiliary of other malific agencies, such as climate, malaria, &c. (Table 5). While the diet-scale for sea-service acts not only as a depressing medium in cool regions (Table 2), and a fertile source of sickness in various forms, some fortunately comparatively rare in Her Majesty's Navy (though of frequent occurrence in the merchant service, and others, a still too common casualty in both), but becomes in warm latitudes (where it is not only too salt but too highly animal, and often conjoined with climatic and other influences) a cause of serious bodily detriment (Tables 1 and 7), and one of the most frequent of all originators of disease among seamen.

Thus, theory and experience, physiological reasoning and pathological fact, all testify that the present naval dietary, suitable enough because the best that could be devised for a bygone day, is in several respects erroneous and unfit for an age of naval reform and sanitary innovation;

especially when a necessity is evident for no longer retaining the salt meat that forms so material a constituent of our present system, or for enforcing the continuance of an extra-tropical regimen in inter-tropical regions, and when a general improvement in the plan of provisioning our fleets appears so highly expedient. With salt meat expunged or almost banished from our sea-dietaries, and special provision made for tropical, as has been long and wisely done for arctic service, usually far less detrimental to health, we might expect the salubrity of our ships to equal if not surpass that of crowded communities on shore. A judiciously selected dietary would do more than anything else to preserve the vigour and physique of our men, and the efficiency of our crews, both in and out of the tropics; and sickness would be equally influenced thereby. It is by the introduction of a prophylactic regimen, rather than by the administration of corrective medicinals, such as lime-juice, that is the only sure, as it is the sole philosophical plan, of wholly extirpating scorbutus and its numerous closely allied ailments, which are best met by checking them in their origin, and making an advance on the old curative method, to obviate their approach. To attempt to eradicate these by the plan now practised, that of giving an antidote along with the hurtful agent, and first inducing disease and then supplying medicine to remedy it, is as unwise as would be an endeavour to permanently cure ague by administering anti-periodics without removing the affected from the malarious district which produced, and is likely to protract, his disease; or to subdue an epidemic of fever of appreciable and accessible derivation by treating individuals without checking the subtle poison which overpowered them. And it is by the substitution of a diet which is not only free from this intensely saline impregnation, and other obnoxious elements, but also more akin to what nature suggests and common sense advocates, in place of the present tropical scale, that we may expect to decrease the number of so-called tropical diseases, and make the health of seamen serving in warm latitudes resemble more that of the natives, although we need never expect them to enjoy a corresponding immunity from endemic ailments. While a better-selected fare would also tend greatly to prevent the acquisition, or the development where they already exist in a latent form, of struma, rheumatism, secondary syphilis, and similar constitutional taints, which are frequent sources of sickness among seamen, both as single and conjoint morbific agencies, and which nothing is more likely to induce than defective or erroneous dieting.

A limitation in the issue of salt meat at sea, amounting almost to its total abandonment as an article of diet, is a reform which appears unavoidable. But although this would of itself greatly diminish disease, the welfare of the sailor requires no less than a fourfold instead of the present twofold dietary. And it is a system which has an appropriate scale for sea and harbour in temperate climates, and a separate and special provision for these services in the tropics, that can alone raise the health of seamen to its highest standard; that will decrease the sickness which is still more prevalent than it need be in all latitudes, especially in the tropics, and render the salubrity of the latter to seamen more akin to that of colder regions, and its diseases relatively not more numerous or serious: results which are all the more likely to ensue if the innovation in question is aided by other changes now in progress in the internal economy of the service, particularly more perfect ventilation, careful

selection of strong young men for service in warm climes, and either shortened commissions or frequent reliefs of ships by others from temperate regions. But this important and essential modification in the victualling of the navy has more than its highly beneficial influence on health and the prevalence of sickness to recommend it; and there are other reasons for giving up the old, and other motives for constructing a new dietary than merely medical ones. For not only would the diminished monotony which is a concomitant of the change be a material boon to the sailor, especially if the substitute supplies different kinds of meat, and not only beef and pork, but also mutton, veal, fowl, &c., and a better class of cook is provided, and a remodelled *cuisine* which does not limit his culinary efforts to invariable boiling; but the reform would effect an actual pecuniary economy, both in the necessary food, a more limited issue of lime-juice, a decreased expenditure for physic and medical comforts, and a diminished outlay for hospital, invaliding, funeral expenses, and training new men, that would follow the advent of an innovation certain to be at one and the same time healthier, pleasanter, cheaper, and more satisfactory to the men than the antiquated usage it had supplanted, hallowed perhaps by custom but contemned by common sense*.

Instead of entering into minute details of the dietary that would be more appropriate for seamen, a few general indications as to the best forms of food to adopt in lieu of, or in addition to those now in use, appear all that is necessary to give here. A recent Admiralty Circular orders that "preserved beef be issued on every alternate salt beef day at sea"†. This is an important step in the right direction, that will materially diminish the injurious influence of salt-meat dieting, and doubtless preliminary to a more thorough reform; for if we would have this completely annihilated, it would be prudent to limit it to once a week in temperate latitudes, and perhaps still more in the tropics. The

* The following carefully computed Table will show the cost of an ample dietary that would give $\frac{3}{4}$ lb. of preserved meat at sea, and $\frac{1}{2}$ lb. in the tropics, six days per week (either of them fully equal in nourishing powers to 1 lb. of salt beef or pork) with a suitable allowance of preserved potatoes and rice to alternate with flour pudding and pea-soup.

	Present scale.	Proposed scale.	
		Extra-tropical.	Tropical.
	pence.	pence.	pence.
In harbour	11·11	11·11	9·94
At sea	13·30	14·86	12·43

Thus, the sea dietary for temperate latitudes, 14·8 pence per man per day, would be somewhat more than that now in use, viz., 13·3 pence; but that for tropical regions rather less, viz., 12·4 pence; while the tropical harbour scale would diminish from 11·1 to 9·9 pence. Preserved meat has been reckoned at one shilling per pound. And adhering to our former estimate of an average navy of 50,000 men, of whom one-fourth, or 12,500, are serving at sea, and an equal number employed in tropical regions, it will be found that the new dietary would be cheaper than the old by 3·6*d.* a day, or £5 11s. 8*d.* a year. From this we may at least conclude that no additional expense would be incurred.

† April 12th, 1867.

impossibility of procuring fresh meat, strictly so called, except in harbour, necessarily limits us to the use of this substitute. And it is much to be regretted that no variety of preserved provision yet made is entirely faultless, or capable of fully supplying the place of the newly slaughtered animal. But of all the varieties yet manufactured, whether sun-, smoke-, or stove-dried, sugared, spiced, &c., the ordinary tin-preserved meat in the same or a similar form to that now employed, appears, when of good quality, to combine the greatest number of advantages with the fewest disadvantages. Nor should we, though desirous of a better, that may be not only more like the original, but of superior hygienic properties, despise the by no means very defective or unpalatable forms we already possess, and suffer salt meat to continue to sicken our sailors and cripple our fleets, but prudently accept the material though imperfect improvement, and substantial though incomplete results, we already may.

A fine field for practical scientific research is that which has for its aim the invention of a mode of preserving edible animal tissues, so that they may lose little or none of their primitive physical appearance or chemical properties, and when cooked resemble actual fresh meat as closely as may be in flavour, juciness, and nourishing powers. It is still a problem how to limit or nearly altogether prevent those putrefactive changes which usually speedily follow death, and whether this is to be effected by the action of some chemical introduced into the blood during life either by the stomach or lungs, and thence carried to the tissues, the same substance acting both as a poison to the animal and a preservative of its body, though subsequently inert to the consumer, or achieved by some post-mortem process which brings the chemical in close contact with every part to be preserved, like Morgan's method of vascular injection, who had he pointed out a better anti-corruptive than the salts now employed, would have far enhanced the value of an invention at once the most rational yet devised for bringing anti-putrefactives in intimate relation with each particle to be acted on, and so simple that we can only wonder why it was never before thought of. The natives of North China allege that they possess some root which, given to an animal before death, has the property of preserving its tissues from putrescence. This may not be altogether fabulous; and the hint at least is worth having. As we now have animal, vegetable, and mineral matters which prevent disease; so others may yet be found out which oppose decay. We already know that certain articles used as food, *e.g.* tea, coffee, alcohol, are conservative of the living tissues, while others, *e.g.* salt, tend to facilitate their disintegration, at least when given in excess. And we may yet detect more active agents of the former class than we now possess; and medicine aided by her handmaid chemistry, may give to the world a discovery that would benefit other nations and other navies besides our own, by furnishing cheap food to the million and healthy fare to seamen, in addition to giving nature her safest and best ally in the preservation of health at sea, and the naval surgeon his surest aid both in the prevention and cure of sickness.

But while striving to avoid the danger arising from a salt-meat diet, we must not fall into that apt to result from one too exclusively fresh. Without a due supply of an appropriate vegetable element, the latter would be as likely to induce disease of the scorbutic type, as would one of the former class. For with the exception of lime-juice, the split peas,

flour, biscuit, and other matters which form a large part of the present naval dietary, are more nitrogenous and muscle-yielding than strictly speaking anti-scorbutic; and we therefore cannot rely on them to prevent this issue. And yet there is no necessity for again falling back on what are always to be deprecated and, when possible, avoided, viz. medicinal prophylactics like these now in use, or for choosing any other than a dietetic to prevent the anticipated evil; inasmuch as we possess in preserved potatoes not only an admirable preventitive of the cachexy, but an abundant, cheap, easily kept article of food, which seamen would appreciate if good and well cooked, and which, given alternately with those above mentioned, would tend greatly to maintain the balance in the animal and vegetable element necessary to preserve health.

The tropical dietary ought to be specially modified; for though seamen do not lead the same vigorous life there as in temperate regions, they do not pass an inert lazy existence like the natives of warm latitudes, nor have they so little physical exertion as the private European residents, or even the soldier on shore. We ought not therefore to diminish the amount of nitrogenous aliment to make it correspond with the allowance of the latter, or even with that of the aboriginal, but should give a judiciously regulated proportion of fresh meat to supply the muscular waste. And in order to augment the equally or even more needful vegetable element in the tropical dietary, no better article of food can be had than the rice which nature, with singular significance, supplies so lavishly in most warm countries; for, as already mentioned, the pea-soup, pudding, and biscuit of the present dietary are so highly nitrogeneous that an increase in the quantity issued, so far from supplying the vegetable matter specially wanted, would only tend to induce disease by throwing an excess of azote into the blood, a result that would not follow ingestion of the starchy hydro-carbonaceous components of the latter. Again, the ration of rum, already wisely, beneficially, and easily abandoned by a considerable proportion of the merchant service, might be advantageously supplanted by coffee in temperate latitudes, and lime-juice in the tropics, both of them healthy drinks.

The dietetic reform here recommended, as likely to be followed by such beneficial and wide-spread results, when fairly looked at, does not involve so material a change as cursory consideration might lead us to suppose. And the adoption of a preserved meat diet, to correspond in quantity with climate, for the present ration of salt meat, with a modified regimen, less animal and more vegetable for the tropics, could be effected without making any or only a very unimportant addition to the number of edibles now in use on shipboard, either for ordinary or particular purposes; and it would only be necessary to increase the quantity of some, *e.g.* preserved potatoes and meat, rice, &c., now chiefly issued as medical comforts, and diminish others in proportion, to meet the new demand. The Dutch, who have a distinct scale for ships serving in their East Indian possessions, appear to be the only power that makes special provision for the tropics; but as it contains little fresh meat or suitable vegetable matter, although both are plentiful and cheap, it is less fit for the occasion than it might be.

The regulation of the change of diet to correspond with climate raises the important question whether it should be an immediate or a gradual process; this experience alone can satisfactorily decide; but we know that nature for the most part rebels against abrupt mutations, whether directed against the ordinary routine of our mental or physical organization. Rapid transitions of temperature or climate, from cold to hot and from hot to cold, are dangerous, and apt to induce serious disease; while sudden changes in food, as from animal to vegetable, or *vice versâ*, are equally hazardous, and nearly as frequent a source of sickness. But although the system here proposed would involve a combination of both conditions, inasmuch as the frame would have to bear an alteration in the diet while undergoing an important revolution from climatic agencies, we must remember that the modification in diet, in this instance, is a salutary and not a disease-generating one, and is meant to meet the requirements of the fabric while subjected to the meteorological vicissitudes, the injurious effects of which it is calculated to lessen. And we therefore conclude that it would not be so fraught with peril as might be supposed, especially as the change is not so very material, and is one not of kind but merely quantity. The fresh meat, rice, flour, pease, and other food fitted for cool climates is exactly that which is best suited for the tropics. We have merely to adapt the amount issued in accordance with the easily understood requirements of the fabric; and any slight risk that might be run would be avoided by a slow substitution of one scale for that which is to follow, and first alternating the two, and then gradually superseding the one by the other regimen. Thus the change would be neither sudden nor great, and consequently devoid of danger.

As a rule, the three great varieties of climate, the frigid, temperate, and tropical, blend so imperceptibly, that is often difficult to say when we quit the one and enter the other. Nor can we judge of climate by latitude alone; for many places which are physically in a temperate region, possess a decidedly tropical meteorology, and *vice versâ*. Still it is absolutely necessary, in making the change of diet here indicated, that we should have some criterion by which we may decide where one begins, and another ends. Fortunately, though zonal position is fallacious, and the belts of Capricorn and Cancer will not serve our purpose, we have in heat and thermometric lines an easy guide by which we may tell when we have reached or made our exit from a tropical district. And if we take the isotherms of 40° and 70° Fahrenheit respectively as an index, we can never far err in our estimate of the climatic character of any locality, and may safely lay down as a law that all which possess an average annual temperature above the latter, are in the tropics, while all between the two are in the temperate zone. And knowing as we now do with yearly increasing precision the general and medical climatology of almost every coast along which our ships of war cruise, the exact spot where the one diet is to be first alternated and then superseded by the other on entering or leaving the tropics could in most cases be definitely fixed. While in correspondence therewith, the ports of every station might be arranged in two classes, one being tropical and the other extra-tropical; and in doubtful cases, as at sea, almost all of our ships of war have a further safeguard in ever-ready professional counsel. The store-ships and depôts which exist on all the foreign stations to supply provisions as wanted, are an additional advantage calculated to facilitate an early and complete reform in our modern (yet ancient) diet-system for seamen.

ON THE

DIETING OF SEAMEN.

BY

ALEXANDER RATTRAY, M.D., SURGEON R.N.

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The domestic history of Her Majesty's Navy during the past hundred, and especially thirty, years, is one long chapter of reform. Preeminently noteworthy is the gradual rise of the now firmly established doctrine that prevention is better than cure. At the present day the most important, if not the majority, of medical legislative enactments have that object principally in view; and that the value and wide bearing of the above aphorism are as fully recognized by the State as by the public, is shown by the commendable attention now paid to judicious suggestion. One of the characteristics of the age is solicitude for all that concerns the welfare of seamen; and in no service are their comfort, happiness, and health more sedulously watched than our own, as in none have more numerous and important improvements relating thereto been introduced, especially of late.

Among other innovations, the victualling has undergone marked changes; and it is well to remember that though various agencies may sooner influence the health of seamen, few have a greater effect on their general well-being and utility than their diet. Health is intimately related to happiness, and gratitude to gratification; feed them properly, and they will be both healthy and happy; they will fight well, and work cheerfully; their duty will become a delight, and obedience a pleasure. From no other source are contentment and love for the service more likely to spring than from one which appeals so directly to the individual, and ministers so much to his enjoyment; and the little control seamen have over a matter in which they themselves have the chief interest, is a claim for sympathy, which, added to an earnest desire for their benefit, makes how to diet them judiciously a subject of more than professional interest, and gives sufficient warrant for continuing reforms, which it is the province of medicine to point out, but the privilege of the State to act upon; nor, if we can make seamen stronger and longer-lived, ships less sickly, fleets more efficient, long voyages, foreign, and particularly tropical, stations less unhealthy, will further innovations requisite to attain so important and desirable an object be deemed superfluous or ill timed.

1st.—*The General Principles of Dieting Seamen.*

Recognising the maintenance of a healthy navy as the great aim of naval medicine, and hygiene as the principal means by which this may be effected, our first duty is to carefully select men, physically, morally, and mentally fit for the service, and especially boys, more plastic in body and brain; but, having acquired such a force, our second object, of equal moment, is to keep them healthy.

Unremitting attention to sanitary indications is as necessary to retain the vigour of a ship's company as constant drill and physical training to render them efficient men-of-war's men. Fortunately, at least, some of the agencies by which this result may be effected are as much under control here as elsewhere.

From his earliest existence man is subjected to certain health-giving influences, as well as to others which are disease-inducing; so that at all ages, and in all conditions and climates, health may be regarded as a constant struggle against sickness, life against death; and, for seamen, there are many obvious reasons for vigorously aiding all salutary and lessening all injurious agencies.

Food is one of the most important agencies that act on the human economy, one which may influence the system of the sailor either for good or evil, and be health-infusing or health-impairing. From the moment of our endowment with life, it is indispensable to comfort, happiness, health, nay, existence. Man's frame is not permanent, but temporary, and constantly undergoing change. To meet this "constant change," he needs aliment; and to effect its purpose, it must be administered under certain conditions as to the quantity and kind of its animal, vegetable, and mineral constituents. It must be appropriate, sufficiently plentiful, of good quality, and free from noxious elements. Good water, proper food, and pure air, are essential to health; the first two are to furnish the blood with material to sustain and enable the system to carry on its various functions; the latter to elaborate that fluid, and remove impurities.

It is the food which enables the brain to think, glands to secrete, muscles to move, body to grow and renew its tissues carried off by interstitial decay, preserve its temperature, perform the numerous functions of animal and vegetable life; and the various organs, many parts of one great whole, to act vigorously and in unison. Without a due supply of appropriate food, we cannot expect to make healthy sailors of growing lads, give athletic frames to seamen, or make anything else than impoverished blood ill adapted for vital processes, and for giving stamina to the system to enable it to resist debilitating agencies, and ward off threatened sickness. Without a proper diet, the most important of the three necessaries of life—attention to other hygienic agents, so necessary on shipboard, especially cleanliness, dryness, and ventilation—will prove unavailing to preserve health and prevent disease.

Corroborative evidence of this was adduced in a former paper*, which proved that the majority of seamen gain in flesh, strength, and health in temperate climates, like that of England, on a judicious diet; and that many will gain in flesh, or at least lose less, in a debilitating tropical climate than they otherwise would, provided a diet including fresh meat is administered. On the other hand, when disease has gained a footing, it is the gastric and pulmonary supplies that give the system strength to cast it off speedily, to recover rapidly, and quickly bring back its wasted and weakened organs to their wonted bulk and vigour; that restore loss

* Statistical Report of the Health of the Navy, for 1866; Appendix, pp. 47–53.

of substance from excessive interstitial waste or surface lesions, both common sequelæ of sickness: hence the value of a constant provision of nourishing and health-giving food, and disadvantage of the use of that kind which is weakening and health-impairing: the importance of the former both in normal and abnormal life, health and disease, the preservation or restoration of the one, and prevention or cure of the other, and more particularly its great benefit when health and strength are apt to be undermined by other powerful agencies which an injudicious diet might materially intensify. With all three forms of aliment, poisons may be introduced into the blood, and many well-known aliments and morbid states of individual organs, or of the system generally, be thereby induced.

Improper food has long been a fertile cause of sickness at sea; and though the diet has been greatly improved, even since the important reforms suggested by Blane in the end of the last century, it becomes us to inquire whether our advanced knowledge of the causes of disease may not still further benefit seamen by increasing their salubrity. The average death-rate and amount of sickness among seamen, at least in Her Majesty's Navy, are, even now, lower than in civil life. But when we consider that the service consists chiefly of picked men and boys, of the healthiest ages, selected for their vigour, and subsequently trained and treated solely with a view to convert them into physical athletes, from whom such as break down are being constantly removed as they occur by invaliding, and that the two extremes of life, old age, and especially childhood, which materially augment disease and death among landsmen, are wanting here, we can only conclude that the reason why both have not yet attained a considerably smaller ratio is, that certain causes of detriment are still at work to prevent it. The detection of these, of how this superfluous sickness and suffering, loss of health and life, may be prevented or lessened, and whether any of it may be traced to our present diet-systems, are therefore important questions.

2nd.—How Seamen are Fed.

It was principally to the insufficient nutrition of the erroneous dietary in use in Her Majesty's Navy prior to Blane's reform of 1797, deficient in quantity and defective in quality, that the scurvy, dysentery, fever, putrid ulcer, and other diseases of debility, which formerly ravaged our fleets, and crippled and killed many more than the conflicts then so common, were principally due: though long subjection to the obnoxious diet during protracted blockades and tedious voyages, and limited opportunities of procuring fresh supplies when abroad, aided by overcrowding in small ships, and the then imperfectly studied and enforced public and private hygiene, acting on the unhealthy frames of a class differing from our modern carefully selected man-of-war's men, doubtless greatly disposed to and aided the issue in question. Since then there has been a material diminution in the amount of disease and death; chiefly contemporaneous with, and bearing the relation of cause and effect, to various hygienic, and especially dietetic, reforms. In the above-mentioned year, the scanty and unwholesome victualling was changed, greatly improved, strictly regulated, increased by at least one-third, and lime-juice issued at sea. How meagre was the previous diet is proved by the fact that the new scale gave no more than $\frac{3}{4}$ lb. of salt meat and 1 lb. of biscuit. Since then various alterations have been introduced, such as issuing salt meat at a much earlier period after being cured, biscuit sooner after baking, and the supply of better articles of food*. In 1815, iron water-tanks, previously partially introduced in place of casks, were more generally adopted, and gave an ampler supply of pure water. In 1825, cocoa was given in lieu of gruel (burgoo) for breakfast; the daily half-pint of spirits, one-half usually issued at dinner, the remainder in the afternoon, was supplanted by one gallon of beer at dinner, and tea or coffee in the afternoon. In 1831, the beer was superseded by $\frac{1}{4}$ pint of rum for dinner grog. In 1850, the daily allowance of biscuit was increased to $1\frac{1}{4}$ lb., and salt meat to 1 lb., with various minor improvements. In 1867, an Admiralty Circular made the dietary as it now stands (Table I.), and ordered the issue of $\frac{3}{4}$ lb. preserved meat every alternate salt-beef (*i. e.* every third day), with preserved potatoes or rice. Although the naval dietary has thus undergone various alterations, it is worthy of notice that the diet which formerly produced such grave results was not very dissimilar in kind from that now in use. So that if the regimen, the crowded state of vessels, and long voyages had not undergone a more decided improvement than the diet, these benefits would not have been so marked. Although we never meet with the above-mentioned ailments now in the severe and fatal type of that age, they have not been eradicated, but only diminished in force and frequency; and as long as the most fertile and constant causes of all continue in operation, we may still expect them to appear in minor and milder forms, when other conditions necessary for their development are present. Ulcer and dysentery, at least, and other ailments that often directly or indirectly result from peculiarities in provisioning, and have a distinct scorbutic alliance, are still frequent at sea. Though several times amended, it was never in the right direction, and each successive alteration, in one article of diet at least, only tended to intensify the evil by increasing the quantity issued. In fact, it was not till the last-mentioned change that the innovation which of all others is most likely to perfect the healthiness of the service, viz. an improvement in the sea-dietary, and the introduction of preserved meat and vegetables, was begun. For the experiments previously detailed† show how much a diet which is only partially fresh, influences health, weight, and vitality; and proves generally that diet is still a powerful instrument, not only in inducing sickness, but impairing health, and that the late scale‡, especially when conjoined with impure air, broken rest, climatic vicissitudes, malaria, and other insalubrious agencies, was in several respects erroneous, and neither health-giving nor health-preserving, but the reverse; and similar results may be predicted of any scale imposing a too frequent issue of salt provisions; for all experience teaches that any systematic departure from the laws of health must exert its influence on the system sooner or later §. The principal conclusions drawn from the experiments now alluded to were—

* Wilson, Statistical Report of the Health of the Navy for 1830–36.

† Statistical Report of the Health of the Navy for 1866; Appendix, pp. 44–71: On the Influence of Diet and Climate on Health and Disease, as indicated by the Weight.

‡ The majority of these experiments were made before the introduction of preserved meat came into force on the Australian Station.

§ Carpenter, 'Human Physiology.'

First. That the too free use of salt meat, with a limited supply of anti-scorbutic vegetables, is not only an occasional cause of true scurvy during long voyages, especially towards their termination, but of other ailments that evidently mark an incipient stage of the diathesis, *e. g.*, phlegmon, abscess, &c., and also the chief cause of the obstinacy of many local diseases, such as ulcer, &c., claiming often a different origin.

Second. That the imperfect sustenance and mal-nutrition of a salt-meat diet may generate *de novo* not a few of the manifold forms of struma and other diseases in which mal-assimilation is a prominent feature, and perhaps rheumatism, both frequent among seamen in all, but especially tropical, latitudes, and that it certainly develops and aggravates active disease in systems previously tainted with other congenital or acquired blood-poisons, syphilis, rheumatism, scrofula, and corresponding constitutional cachexies.

Third. That the use of a diet-scale adapted for temperate latitudes in tropical climates, and especially one with salt meat as a chief item, is another frequent cause of disease. For not only does the resulting over-repletion and excessive azotization and carbonization of the blood tend to induce affections of the eliminatory organs which have to get rid of the superabundant matter, and so cause hepatic, nephritic, cutaneous, febrile, and other disorders, but these causes also tend to originate dysentery, diarrhœa, and other congestive ailments of the already over-excited gastro-intestinal canal. These results are all the more likely to follow if the diet is not only excessively fleshy, but also salt and laden with chemicals which both irritate the gut and add to the blood-vitiation, and thus directly and indirectly engender liability to local congestions and hæmorrhage from slight causes, with a tendency to disorganisation of tissue, and the development of ulceration, especially of the mucous surfaces.

Fourth. That the debility and asthenic state induced by a salt-meat diet, especially the superfluously animal one of the tropics, predispose the system to disease, and render it prone to epidemic, endemic, and especially malarious ailments, all frequent, serious and fatal among seamen, especially in low latitudes, where climate aids both in weakening the body and depraving the blood.

Fifth. That even when salt meat does not originate actual disease, it causes a marked decrease in weight and an impaired physique, strength, and vitality, when prolonged beyond a certain time, which may be regarded as an indication of failing health, or tantamount to a manifestation of incipient illness.

Sixth. That salt meat in the tropics is not only a direct source of detriment, but tends to intensify the injurious effects of climate, as manifested by an increase in the usual physiological and pathological phenomena, the former shown by loss of flesh, the latter by a large amount of sickness. To these we may add—

Seventh. That the ration of rum is doubtless injurious in most, and decidedly hurtful in warm regions; as it slowly and insidiously impairs health, and both excites and predisposes to disease, by causing gastro-intestinal irritation and congestion, as well as hepatic and other affections arising from supercarbonized blood.

The loss of flesh here alluded to (especially observable from Table II., Appendix for 1866) is really the essence of scurvy, its primary stage, arising from the same cause as its more serious forms of dysentery, fever, and putrid ulcer, once so common; and the correspondence in principle and nature here evident between the general loss of substance, as indicated by the decrease in weight, from absorption of internal tissue in this the early stage of the disease, compared with that of the visible, external, and superficial loss of substance so remarkable in the cutaneous ulceration of advanced scurvy, will surely be apparent even to the non-professional mind.

And the reason why the diet formerly in use caused so many physiological and pathological phenomena, and why it was necessary to partially supplant salt by preserved meat, is obvious enough. Nature has not only bountifully supplied us with food and made special provision for each zone, but has laid down definite laws of feeding for our guidance, both in our own region and when we migrate to others. And we never find the natives of tropical countries supplied with a highly fleshy and nitrogenous diet like that usually given to seamen in warm latitudes; but a more vegetable and starchy one, which furnishes all the elements necessary for the climate, while it throws no superfluous matter into the blood. This food is always found in the fresh, and never in the salt state. The diet should always therefore be as fresh as possible, and different in the tropics from elsewhere, otherwise various untoward results occur. The ingestion of highly salted, shrivelled, hardened meat, deprived of its nutritive qualities by pickling and boiling, acts as a local mechanical irritant. Blood elaborated therefrom is impoverished and vitally changed, unfit for the constructive and reparative processes, for preserving or restoring the bodily vigour, and tends both directly and indirectly to induce disease. These results are specially imminent in the tropics, where gastro-intestinal ailments are common, the system revolutionized and debilitated by climate, the blood deficiently oxygenated by the influence of the latter, and overcharged by poisons from the usual highly nitrogenous salt-meat diet. If we give the digestive organs faulty food on which to act, the blood unfit elements to assimilate, and the body plastic matter ill adapted to carry on its various functions, all three necessarily rebel. Thus disease begins when it would not otherwise occur, and frames we wish to strengthen are debilitated; so that instead of warding off malarious, epidemic, and other adverse agencies, they readily succumb to them, and with greater difficulty recover from their influence.

As with the late introduction of preserved meat into the naval scale, so it should be our constant endeavour to remove every source of detriment from the seaman's path. His diet should be one that prevents all these contingencies, preserves the weight and physique instead of impairing them, increases health instead of undermining it, and lessens disease instead of augmenting it. If sickness does come, let it be from other agents than the food. The majority of the dietaries now in use, however, it is only fair to remember, were originally constructed when few served in the tropics, when the necessity for a special tropical regimen was unrecognised, and the meat-preserving art in its infancy.

The following scale will show how seamen are now dieted in Her Majesty's Navy :—

TABLE I.—*Present Naval Dietary.*

Daily	Biscuit	$1\frac{1}{4}$ lb.	
	Sugar	2 oz.	
	Chocolate	1 oz.	
	Tea	$\frac{1}{4}$ oz.	
	Spirits	$\frac{1}{2}$ gill.	
	Harbour:		
	Fresh Meat	1 lb.	
	Vegetables	$\frac{1}{2}$ lb.	
	At Sea:		
Alternately.	Preserved Meat	$\frac{3}{4}$ lb.	
	,, Potatoes	$\frac{1}{4}$ lb.	
	or Rice	$\frac{1}{4}$ lb.	
	or Rice	$\frac{1}{8}$ lb.	
	Preserved Potatoes	$\frac{1}{8}$ lb.	
	Salt Beef	1 lb.	Once a week, alternately, in harbour.
	Flour	9 oz.	
	Suet	$\frac{3}{4}$ oz.	
	Raisins	$1\frac{1}{2}$ oz.	
	Salt Pork	1 lb.	
	Split Pease	$\frac{1}{4}$ lb.	
Weekly	Mustard	$\frac{1}{2}$ oz.	
	Pepper	$\frac{1}{4}$ oz.	
	Vinegar	1 gill.	
	Oatmeal	3 oz.	
	Celery seed	$\frac{1}{2}$ oz. to 8 lbs. pease, or 24 men.	
	Lime Juice	$\frac{1}{2}$ oz.	Issued at discretion of Surgeon.
	Sugar for ditto	$\frac{1}{2}$ oz.	

This may be described as a *mixed* diet, consisting partly of animal and partly of vegetable matter, constructed for men of active habits, for the temperate climate of England, or like latitudes, in which they are chiefly employed, and for the Anglo-Saxon race, by which our ships are principally manned. It is, moreover, a *double* dietary, inasmuch as the impossibility of issuing fresh meat and vegetables during long voyages necessitates the employment of substitutes viz., salt or preserved meat for the former, and flour-pudding, pea-soup, preserved potatoes, and rice for the latter. It is also a *universal* dietary, because used in all latitudes, climes, and countries, except Arctic regions, for which special provision is usually made; and it may be fairly regarded as a *representative* dietary, from resembling those of the mercantile marine and most important civilized nations, whose ships, as with England and her colonies, belong to, and cruize chiefly in, the temperate zone. Hence the subject is one in which, if not in foreign fleets, at least the 250,000 sailors of the merchant service and 96,000 of our colonies are as much interested as the 50,000 of the Royal Navy. Why should the dieting of seamen in the merchant and Imperial services, especially large ships on long voyages, differ much, if at all? Or, if a scale is found to be healthy, sufficiently abundant, and generally suitable for man-of-war's men, why should it not be equally well adapted for seamen generally, special attention being paid to national habits, prejudices, and peculiarities?

3rd.—How Seamen ought to be Fed.

The intimate connexion that exists between diet on the one hand, and health and disease on the other, has been long recognised. We are told that to know the cause of disease or bodily detriment is sometimes to be able to cure, often to prevent it*. Very simple conditions as to dieting caused the previously mentioned manifest effects; and, judging from former improvements in provisioning, might not equally simple measures be sufficient to prevent such subtle forms of disease as may still remain? There is reason to believe that the more we elaborate our modern dietaries, the more decided will be the health and efficiency of seamen generally; while the sickness now prevalent both in temperate and tropical latitudes will thereby be greatly diminished.

Nature has laid down certain great laws of feeding which it is our highest wisdom to follow; and theory indicates that our aliment should everywhere be fresh, like the creative supplies, each lavishly provided in its own zone, but less plentifully elsewhere; that in temperate latitudes it should be of mixed animal and vegetable matter, and more highly vegetable in the tropics, in conformity with native usage, and chiefly animal and oily in Arctic or sub-arctic regions; and that it should everywhere present considerable variety of detail. While experience testifies that the Anglo-Saxon race attains its highest health when individuals conform closely to these conditions, and modify their diet and regimen according to climate, and other specialities of the latitude in which they happen to be placed. Regarded from this point of view, the majority of the diet-scales now in use have certain faults, which may easily be rectified; thus,—

1st. They are too unvarying in all latitudes, tropical and temperate.

2nd. The highly salted beef and pork issued at sea, and scanty supply of proper vegetable matter, are objectionable, especially in the tropics.

3rd. The same diet is given in warm as in cold regions, instead of one less nitrogenous and stimulating, and more vegetable.

4th. The spirit ration, which is not only unnecessary to comfort but injurious to health, especially in the tropics, is also obnoxious.

Thus, as a rule, our present sea dietaries for all latitudes, and also the harbour scale for the tropics, are injudicious; and the harbour scales for temperate regions is all that might be retained; though even they might be advantageously amended.

The admirably planned scheme now in use in Her Majesty's Navy, certainly the most judicious of all existing scales, has certain recommendations which ought to be kept in view in framing new ones: for example, it is a mixed diet, such as best suits our race; sufficiently ample for men of active habits like seamen; admirable in kind, at least as far as the harbour diet for temperate latitudes is concerned, besides containing many articles not only nourishing but well adapted in other respects for the exigencies of life at sea.

Before attempting to frame a dietary, we should have definite objects in view, and clear notions as to its character and requirements. Now, a

* Watson, 'Practice of Physic.'

safe rule in provisioning seamen, applicable in all circumstances, and for the most part easily carried into effect when fairly encountered, is to regulate the ingesta so as to supply the blood with plastic elements of such kind and quantity as will counterbalance the constant drain which the various processes of animal and vegetable life involve, and increase, diminish, or vary them so as to enable growth to equal waste of tissue. To preserve health and prevent disease, we must, as much as possible, make the diet accord with the wants of the system in all the diversified conditions as to climate, work, &c. in which it may be placed. We ought to administer such aliment as will furnish material to assist nature to convert the growing lads and young men who form the mass of our ships' companies, into the athletes required to man our vessels; both bring them to, and preserve them in, the highest state of physical efficiency wherever sent, and however employed; and not only keep them in health, but have no tendency either to induce disease *per se*, or develop or aid other injurious agencies, whether of internal or external origin.

To make a suitable dietary, then, it must possess certain requirements, and the principal things which ought to be attended to in framing it are, first, the *nature* of the food; second, its *quality*; third, its *quantity*; and fourth, *variety*. It should be of an appropriate kind, of proper character, sufficiently abundant, and suitably diversified; any material, and especially a prolonged, departure from any one or all of these essentials is certain to be followed, particularly in weakly subjects, and during subjection to other health-impairing agencies common to sailors, by imperfectly performed vital functions, and ultimately disease.

The principal conditions which determine the *nature* of their food are region, race, employment, habits. Man everywhere needs a mixed animal and vegetable diet, necessarily differently apportioned, as already explained, according to climate; and, in each, nature for the most part providentially supplies the exact variety required; highly carboniferous for cold regions where much heat-producing material is needed; chiefly hydro-carbonaceous for warm climates, where inert life involves little muscular waste and necessitates no added heat; and a mixed animal and vegetable regimen for the bodily and mentally energetic natives of intermediate zones, who waste much brain and muscle, and often require additional warmth. And when the inhabitants of either migrate, they find it their greatest safeguard to accommodate their habits, clothing, and, above all, their diet, to the new clime. Our Anglo-Saxon sailors, born, reared, and chiefly employed in temperate regions, obviously require a mixed diet such as we ourselves use, so long as they remain within their limits; but, when they leave them for the tropics, their diet evidently needs to be changed to meet the altered requirements of the system, to be made less animal and more vegetable, and somewhat more like that of the natives. At sea, the impossibility of providing fresh newly-killed meat and succulent vegetables for any length of time prevents this rule from being carried so fully into effect as we could desire, and we must there employ eligible substitutes. Salt and lately-preserved meats, for example, have been given in lieu of the one, and pea-soup, flour-pudding, &c. for the other. This obviously indicated change of diet with climate has been hitherto inadequately recognised, even in private life. The late East India Company and Dutch navies are the only two which have made provision for tropical service. This may be partially, though not altogether, accounted for by the fact that, with the above exception, England is the only nation (France, the United States, and other great Powers not excepted) which keeps up large fleets on foreign and especially sultry stations. With few large and important colonies, and more limited commercial interests, their navies are for the most part concentrated at home; and hence a sea- and a harbour-dietary for the temperate zone, each modified according to national proclivities, is all they possess, and for the most part all they need. In the English merchant service, in which the men are usually engaged for the voyage only, a sea-dietary is what is chiefly required, and is that on which they principally concentrate their attention, but they make no provision for the tropics. Even in the former instances the modification is incomplete. The vessels of the East India Company, employed altogether in the tropics, had separate scales for their Lascar and European crew; but the latter was of the same faulty nature as most sea-dietaries; for though it contained rice and other tropical ingesta, it gave salt meat at sea, and too little vegetable. The Dutch have a distinct tropical dietary in their East Indian possessions, where from one-sixth to one-fourth of their entire navy, and from 1,000 to 1,500 men are serving. But, though the harbour-scale judiciously affords an abundance of rice for breakfast and dinner, at sea it gives little suitable vegetable matter, and no preserved, but only salt meat, and that in too great abundance for the sultry climate, especially as no lime-juice, or other anti-scorbutic, is given to counteract it, as in their extra-tropical dietary, when gherkins and vinegar are issued; and therefore, like the former, it is less fit for the occasion than it might be. The diet of sailors belonging to tropical regions, highly athletic as a class, which consists chiefly of rice, is more appropriate. Experience proves the truth of the laws here laid down, and shows the advantage accruing from a suitable, and the results which follow an improper, dietary. Sailors gain in health, strength, and flesh on a fresh meat and vegetable diet in cool climates (Appendix for 1866, p. 51, Table VI.), while they lose in all respects on one of salt meat (*Ibid.* Table II.), and especially when this is given in a warm, debilitating region (*Ibid.* Table I.), or under other adverse influences like hard sub-solar work (*Ibid.* Table IV.), while these inimical results are materially lessened by the use of a judicious dietary (*Ibid.* Table V.), with fresh meat and vegetables. Facts like these indicate that we should make special provision for tropical, as we have long done for Arctic, service, usually less deadly, and certainly far less detrimental to health.

The *quantity* of food required by seamen is of equal moment. An insufficient supply even of good food will induce impoverished blood, impaired vitality, and ultimately disease; while excess is even more faulty and likely to undermine health, when it does not cause immediate illness. Care is therefore necessary to regulate the supply to the wants of the system. With seamen sent to serve in different latitudes, the amount of work they are called on to perform being much alike in all, climate is the principal agency which influences this also, and a different diet is evidently needed for the tropics; for there they require less heat-giving and perhaps less muscle-making and muscle-stimulating matter than in temperate latitudes, more vegetable, and less animal and fatty tissue. They are less exposed to cold and chilly weather, to abstract heat, and though required to work as hard, the languor which the

climate engenders is apt to diminish their voluntary expenditure of muscle. And that there is a necessity, both for altering the relative proportion of its items, and decreasing the quantity of food issued on proceeding to the tropics, is shown by a wise indication of nature, which induces loss of tone not only in the cutaneous capillaries, but in the coats of the gastro-intestinal canal, the one indicated by increased perspiration, the other by a diminished appetite*. For temperate latitudes, experience proves that the present harbour-scale of Her Majesty's service is admirably adapted as to quantity for preserving health and strength†, and may therefore be fairly taken as a model after which other dietaries may be constructed, if necessary, to replace those now in use. The daily average amount of food and drink best fitted for men of medium size and weight, like seamen, viz. from 5 ft. 8 in. to 5 ft. 10 in. in height, and from 140 to 160 lbs. in weight, has been carefully computed. Parkes gives it as 23 oz. of water-free food, and from 70 to 90 oz. of water, in moderate exercise‡. And chemists have analysed it still more minutely; thus,

		oz.
Albuminous food		$4\frac{1}{2}$
Fatty	,,	1
Starchy	,,	16–17
Total (water free)		22–23§

To this proportional scale we should endeavour to make our sailors' diet in temperate regions correspond. Without reference, therefore, to Liebig's idea of the appropriation of food by the fabric, Haughton's of the relation of food to force, or similar opinions, we may safely take nature and experience as guides; for it is evidently no mere theory, but an "unthought of chemical instinct¶," which leads man to make his choice of diet and nature's provision of aliment accord so closely. But the harbour-scale of the present twofold dietary contains very nearly the physiological proportion of elements here given, thus:—

	oz.
Nitrogenous	5·0
Carboniferous	17·7
	22·7 **

It is therefore theoretically, as experience proves it to be practically, judicious, and well adapted for seamen††. So that in constructing a new dietary for extra-tropical regions we may safely and conveniently take it as a basis, as, both in quantity and character, it is well chosen and tried. That it is sufficiently abundant is proved by the average savings for food not taken up, per man, amounting to about sixty shillings a year. This slight over issue, however, is an error on the safe side, as it prevents any idea of stinting, and obviates the likelihood of waste apt to be engendered by unlimited supply of certain articles, biscuit for example, of some English merchant services.

* Martin on the 'Influence of Tropical Climates.'
† Appendix for 1866, p. 51, Table VI.
‡ Practical Hygiene. § Strange, 'Restoration of Health.'
¶ Aitken, 'Practice of Physic.'
** Letheby, quoted in Aitken's 'Practice of Physic.'
†† Appendix for 1866, p. 51, Table VI.

And it may be safely followed in framing a proper tropical scale, the same articles of food being suitable for both; those fitted for harbour and sea of either region being identical, and requiring modification as to quantity only.

We have no accurate estimate of what should be the relative proportions for the tropics; but it is evident that climate and the system most both be consulted, and the following may be taken as a fair approximate:—

	oz.
Albuminous (nitrogenous)	3
Starchy (carboniferous)	12–14
Total (water-free)	15–17

on which to construct tropical diet-scales. Fortunately, as this would be somewhat difficult were it the only available plan, it is by no means indispensable or indeed necessary. For notwithstanding the labours of Liebig, Mayer, Frankland, Playfair, Smith, Wick, Wislicenus, Haughton, and other zealous chemico-physiologists, the relation of food to the fabric still remains very much in the domain of theory. Our views of the manner in which the various articles composing man's ordinary aliment (nitrogenous, carboniferous, oxygenous, hydrogenous, saline) are apportioned among the different tissues and organs, for their renewal, growth, or the induction of their ordinary vital manifestations, whether brain- or body-work, secretion or excretion, assimilation or disintegration, is still little more than conjectural, and the various opinions held of the use and application of food in the animal economy, though interesting, have little real connexion with the subject in question, or with the proper and practical mode of dieting seamen, which may be done with no guide but nature's provision, native custom, and service experiences, and with no aid either from physiological or chemical hypotheses. The natives, civilized and savage, both of tropical and extra-tropical regions, succeeded in adjusting their diet in this simple and suggestive manner long before such theories were thought of, and indeed the latter are usually merely analyses of diets that have been generally adopted after long trial; and it would be wise to follow their example, and base our dietaries on fact; for, however plausible and curious, doubtless a good test of accuracy, and sometimes a good aid, speculations alone are not sufficient to enable us to construct diet-scales, especially somewhat complicated ones like those required for seamen.

Besides providing for the great divisions of climate, would it not be sometimes prudent to make certain less marked modifications of diet, under special circumstances, to meet those minor variations to which seamen are everywhere subjected in accordance with *season*, especially in variable climates like our own, the Mediterranean, or other regions in either temperate zone. During summer months—especially June, July, and August, when the heat is sub-tropical, the average thermometer about 64° F.*, and very different from the remaining nine, particularly during winter, with its average of 37° F.—might we not prudently give a modified or semi-tropical diet; more vegetable and less animal than now, in accordance with what inclination prompts and nature affords; for it is then that our instinctive desire for and supply of vegetable matter are

* Keith Johnstone's 'Physical Atlas.'

greatest; reserving the extra-tropical scale for the spring, autumn, and winter*. Again, at places like Shanghae (N. lat. 32°), where there is an annual thermometric range of 75° F., should not the diet used during the intensely hot summer be different from that of the cold chilly winter, and the one of tropical or semi-tropical, the other that of temperate latitudes? And on the adjacent verge of the tropical and temperate zones, where season makes the climate either moderately cool or absolutely cold on the one hand, or comparatively hot or even sultry on the other, we might give a modified (semi-tropical), or the tropical dietary (Table II.) according to circumstances. Thus, at Hong Kong, on the verge of the tropics (23½° N. lat.), but with a thoroughly tropical climate, where contrast makes the dry north-east monsoon, or winter season, feel comparatively cold, and the moist south-west monsoon or summer, excessively sultry and enervating, even to the native, would not two different diets be judicious, the ordinary tropical scale for the one and the semi-tropical for the other? All experience testifies how greatly health, both in public and private life, is preserved by minute attention to diet, and strictly adapting it to weather and season, or, what amounts to the same thing, climate; and the sanitary condition of seamen generally would doubtless be materially improved by regulating their food as we do their clothing, &c., and not only adopting a summer and winter scale in temperate latitudes, but having separate ones for the wet and dry seasons of tropical regions, whose climate and meteorology are so distinct. This, however, is obviously a minor consideration compared with the foregoing indication as to a regional system of dieting.

Variety of food is not only essential to health, but far more necessary to the sailor's happiness than generally supposed; and want of it is unquestionably a great fault in any dietary, especially for sea. All medical authorities agree in recognizing its importance as a hygienic agent in preventing scorbutus and other ailments. In harbour the present naval scale gives them fresh meat with soup six times a week, and salt beef with flour-pudding, or salt pork with pea-soup once a week alternately. While at sea the constant round of salt beef and pork, flour-pudding and pea-soup, is alternated every third day with preserved meat and preserved potatoes or rice, the latter being a recent innovation†. Might we not in this also more closely follow nature's guidance, and make both sea- and harbour-dietaries more varied, under the strong motive of a decided increase of comfort, health, and efficiency.

The *quality* of the food issued is necessarily of vast importance in preserving health. Experience proves that in provisioning large bodies, the wisest policy and greatest economy both of men and money is to give it of the best quality.

As both preserved and salt meat are apt to deteriorate by keeping, they should evidently be issued as recently cured as possible. It has been proved over and over again that nothing is so costly in all ways as disease, and nothing so remunerative as the outlay which augments health‡. It would be no economy to cheapen the diet, either by reducing its quantity or lowering its quality, at the risk of health and life. Regarded in this light, a diet may be cheap and yet injudicious;

* In the tropics, sailors eagerly expend their savings on the fruit, vegetables, soft bread, &c. brought alongside for sale, and other articles suitable for the climate.

† April 12th, 1867.

‡ Parkes, 'Practical Hygiene.'

though it may save money, it may be prodigal of life; and that diet alone is truly economical which neither predisposes to nor induces disease, but keeps the men as healthy as may be in all climates and circumstances. Still the most economical of all is necessarily that which is both directly and indirectly so; and would not only cause a diminished primary expenditure, but a reduced secondary outlay for hospital, invaliding, funeral expenses, medicines, medical comforts, and training new men, and, still more important, a diminished sick-list and death-rate.

The laws by which the provisioning of seamen should be regulated are thus very simple and obvious; and it will be clear that there are three great errors to be avoided, viz. the too free use of salt meat, the supply of a diet adapted for temperate in warm regions, and the constant issue of rum. Nature and common sense alike demanding that while there should be a scale for ships serving in temperate latitudes, there ought to be a distinct and modified one for the tropics, each being regulated in quantity and kind to correspond with climate, the impossibility of issuing fresh meat and vegetables at sea in both, and the absolute necessity for having substitutes, necessitating also that each zone should have its special and distinct sea dietary in addition to its harbour-scale, would it not, therefore, be judicious that our dietaries should possess a fourfold instead of the present twofold character, and include—

a. An extra-tropical harbour dietary.
b. ,, sea ,,
c. A tropical harbour ...... ,,
d. ,, sea ...... ,,

Having satisfied ourselves that in most instances a change in our present systems is necessary, the regulation of the diet for harbour service, both in temperate and tropical zones, will be, comparatively speaking, easy. In the former, no better guide to the proper quantity and kind of food can be had than the scale now in use in Her Majesty's Navy; and the only manner in which this might be improved would be by giving a little more variety, as indicated in the following Table: and in the tropics, the quantity of both might be made to accord, more than yet sanctioned, with the requirements of the system and the climate, and made more vegetable, on the one hand, to suit the latter, and less animal, on the other, to agree with the former.

But it is the dieting of sailors at sea which has been, and still is, the great difficulty. If never required to go far from harbour, we might continue the fresh meat and vegetables of the harbour dietary; but ever since long voyages and protracted blockades became necessary, substitutes have had to be provided, it being impossible to make them last more than a week, ten days, or fortnight at furthest. The flour-pudding and pea-soup given for the one were both highly nutritious and well adapted for shipboard; but the salt meat issued for the other, though the best our ancestors could invent, was a rude and elementary article, and most unnatural form of food, which once caused, and even now causes, much sickness, debility, premature decay, and death, especially in merchant services. The necessity for medicinal antidotes, or antiscorbutics, as they are termed (of which lime-juice has long been the favourite and perhaps the best), to counteract the results of the slow cumulative poison of salt meat on the blood and body, alone proves it to be an improper article of diet. But even lime-juice, in which we still put so much con-

fidence, cannot counteract its effects beyond a certain time, perhaps not more than three, four, or at most six months*. And, even if it were possible to issue the best of all anti-scorbutics, viz., fresh vegetables, at sea, it is doubtful whether they would obviate this event, or hinder the injurious consequences of the one from prevailing over the prophylactic influence of the other, and final evolution of disease. There is strong presumptive evidence that, like lime-juice, they might for a time impede and lessen the pernicious results, but would not altogether, or indeed very long, retard their ultimate appearance. The only sure and safe remedy is to remove the injurious agent which causes it, and substitute a prophylactic diet, containing preserved meat. The lime-juice and other anti-scorbutics we now administer fail in their object, inasmuch as they do not always prevent disease in severe or even mild forms; and it appears unphilosophical to give a diet or article of food which subsequently requires the administration of anti-scorbutics, especially when dietetic, the only rational, anti-scorbutics, are available, and a better substitute for fresh meat can be had than salt-cured beef and pork.

Long usage will not hallow the custom that is disallowed as a *necessity*. Knowing salt meat to be a hurtful agent, it should be, if not entirely banished, at least reduced to the minimum, and what remains be less pickled. All dietaries which retain it as one of their principal items will necessarily fail, as hitherto, in keeping seamen healthy. Instead of retaining it, therefore, as a principal item, it should be almost entirely supplanted by preserved meat. We should endeavour to assimilate our dietaries to those of landsmen, and in their construction study the anti-scorbutic properties of the *food* they contain more than the medicinal prophylactics necessary to counteract its pernicious effects, and make hygienic take the place of former therapeutic measures. Thus only may we certainly and surely obviate the evils now resulting from the use of salt meat.

Even recent dietaries give salt meat undue prominence, and only casually mention preserved meat as an optional substitute. Hence a long array of anti-scorbutics—pickles, vinegar, lime-juice, currants, raisins, prunes, dried apples, &c.—to counteract their effects. With this object the East India Company issued an allowance of vinegar, &c.; while the French Imperial navy supplies sauer-kraut and vinegar; the Portuguese, compressed vegetables and vinegar; the Turkish navy, onions, olives, and vinegar; the Dutch, gherkins, lime-juice, and vinegar, and, in their East Indian squadron, onions and sweet potatoes. Admirable additions to any sea dietary, as necessaries or luxuries, these should not be needed as prophylactics. The more rational plan was adopted in Her Majesty's Navy during the Russian war (1853–6), when preserved meats and compressed vegetables were occasionally issued instead of salt meat; and the bad quality of the article, supplied by contract, appears to have led to its discontinuance. Two years ago a similar but still partial attempt was again made; an Admiralty Circular, ordering the issue of preserved for salt meat every third day, with preserved potatoes or rice. The dietary of the Swedish Royal Navy contains the following: "Preserved meats with compressed vegetables may be substituted for salt meat and peas, after being at sea for some time, if necessary" †. This judicious rule, however, has the fault of being optional, and not com-

* Bryson. † From MS. lent by Dr. A. E. Mackay, Somerset House.

pulsory. A few shipowners in the English merchant service also give preserved meat once a week at sea; but, as a rule, none is allowed. All this is in the right direction; but is not the reform incomplete, and should not the issue of salt meat be still further limited, and, finally, when a more perfect meat-preserving process enables, almost abandoned? To diet seamen with a due reference to health and comfort, they should have fresh meat and vegetables at least on six days of the seven; and, granting that preserved meat, though far from equal to fresh, is healthier, more palatable, and altogether better for seamen than salt junk, the questions arise, how often ought we to give it? taking its low price and quality into account*, are we justified in withholding it as we now do; and should we not issue it with equal frequency? If the prolonged ingestion of salt meat four or five times a week impairs health, ought we not to exhibit preserved oftener; and instead of every third day, as in Her Majesty's Navy, once a week in merchant-men, and at option in the Swedish service, give it at least every other day; or, to complete the reform, five or six days per week, and thus fully accept evident, though still limited, advantages?

We have not yet discovered how to counteract the injurious effects of warm weather on the frame of English seamen; but we know that they are materially increased by most dietaries now in use; and it follows that, by acting on the indications here pointed out, improving our diet systems, substituting preserved for salt meat, and specially modifying the food in the tropics, the two changes most required, we shall not only diminish the unhealthy effects of diet, but also those of climate, and thus at one and the same time remedy both—an additional motive for reform.

Although seamen need less food in warm than in temperate latitudes, the amount in the tropics that will suit the lazy native, the inert European, or even the English soldier, whose work is comparatively light, will not do for the active sailor; inasmuch as the heavy gun, cutlas, sail, and other drills common on shipboard, entail the expenditure of much muscular force, which can only be met by an appropriate supply of food; and although this might be effected by a diet nearly entirely vegetable, habit and custom, which render a certain amount of animal food almost indispensable to the comfort of English seamen, perhaps make it imprudent to reduce the quantity by more than one fourth, leaving enough for the wants of the system, and yet not sufficient to cause disease.

The following may be now suggested as an appropriate diet-scale, based on the major indications here laid down, as a mixed diet, fitted for natives of temperate latitudes, but regulated, both as to quantity and kind, for tropical service, special provision being made for long sea-voyages, and the combination of variety with the abundance necessary for men of active habits and athletic frames. The improvement of a scale that contains much that is good is the part of prudence. Between the retention of the suitable, and the rejection of the injudicious, lies the line of all true conservative suggestion. The injurious, distasteful, or unnecessary, are to be banished or limited as far as possible, the weeding of what is noxious, replacement by more nutritious and better-selected articles, and the addition of others likely to prove beneficial to health, comfort, or happiness, being the part of discretion, to which both duty and privilege will endeavour to attain.

* The usual contract price of *salt* beef and pork at Deptford Royal Naval Victualling Yard is 7*d.* per lb.

TABLE II.

Proposed Naval Dietary.

		Temperate, where the Daily or Annual Range of Temperature is below 70° Fahr.	Tropical, where the Daily or Annual Range of Temperature is above 70° Fahr.
Daily	Biscuit, or soft bread (*r*) ..	1¼ lb.	1¼ lb.
	Sugar	(*a*) 2¼ oz.	(*b*) 2 oz.
	Chocolate (*c*)	1 oz.	1 oz.
	Tea	¼ oz.	¼ oz.
	Coffee	(*d*) ½ oz.	..
	Lime-juice	(*e*) ½ oz.	(*f*) ½ oz.
	Sugar for ditto	(*e*) ½ oz.	(*f*) ½ oz.
	In Harbour (when procurable.)		
	Fresh meat (*g*)	1 lb.	12 oz.
	Vegetables (*h*)	(*h*) ½ lb. } alter-	12 oz. } alter-
	Or Rice	(*k*) 6 oz. } nately.	9 oz. } nately.
	Molasses	(*k*) 1 oz. }	1½ oz. }
	At Sea (or when Fresh Provisions cannot be procured).		
	Preserved meat (*l*)	¾ lb.	(*o*) 8 oz.
	Pearl barley (*s*)	2½ oz.	3 oz.
	Or Flour .. } pudding	9 oz.	12 oz.
	Suet .... } pudding	¾ oz.	¾ oz.
	Raisins .. } pudding	1½ oz.	2 oz.
	Or split pease (for soup) (*p*)	⅓ lb.	½ lb.
	Or Rice	(*m*) 6 oz.	9 oz.
	Molasses	(*m*) 1 oz.	1½ oz.
	In Harbour and at Sea.		
Once a Week	Salt Meat (*n*)	1 lb.	12 oz.
Weekly	Mustard	½ oz.	¼ oz.
	Pepper	¼ oz.	¼ oz.
	Vinegar	½ gill.	⅓ gill.
	Oatmeal	3 oz.	3 oz.
	Celery seed	½ oz. to 8lbs. pease, or 24 men.	

(*a*) One oz. each for the chocolate and tea, ¼ oz. for the coffee.—(*b*) For equal division among the two following.—(*c*) At sea, in addition, ½ oz. chocolate and ½ oz. sugar per man of the middle and morning watches.—(*d*) After dinner, in lieu of the spirit ration.—(*e*) After ten days at sea, on the surgeon's recommendation.—(*f*) In lieu of the grog ration.—(*g*) Beef and mutton alternately, and occasionally pork in cold climates; for variety, these might be sometimes roasted.—(*h*) Succulent, alternately with potatoes; in the tropics, yams and pumpkins; for variety the potatoes and rice might now and then be converted into soup.—(*k*) During summer.—(*l*) Beef and mutton alternately.—(*m*) During summer, and for the semi-tropical dietary.—(*n*) Beef and pork alternately; in harbour, the former with pudding, and the pork with pea-soup rations; at sea, the beef on pudding, and pork on pea-soup, days.—(*o*) Cold, if preferred.—(*p*) When pea-soup falls on preserved meat days, the 4, 6, or 8 lb. piece of salt pork or beef (necessary?) for making it may be deducted from the subsequent issue of salt meat.—(*r*) At discretion in harbour.—(*s*) For broth, with the preserved meat.

The following Table will illustrate the practical working of this scale, and show how much variety may be given, with very little trouble, to the sailor's diet.

TABLE III.

To illustrate the working of the Diet Scale for a fortnight, with reference to the Principal Meal, Dinner.

	TEMPERATE—COLD OR COOL CLIMATES.	
	Harbour.	Sea.
1. Sunday ..	Fresh beef .. with potatoes ..	Preserved beef .. with pea-soup.
2. Monday ..	„ mutton „ vegetables	„ mutton „ pudding.
3. Tuesday ..	„ beef .. „ „	„ beef .. „ barley broth.
4. Wednesday	Salt pork .. „ pea-soup ..	Salt pork ...... „ pea-soup.
5. Thursday .	Fresh mutton „ potatoes ..	Preserved mutton „ pudding.
6. Friday ..	„ beef .. „ „	„ beef „ barley broth.
7. Saturday .	„ mutton „ vegetables .	„ mutton „ pea-soup.
8. Sunday ..	Fresh beef .. with vegetables .	Preserved beef .. with pudding.
9. Monday ..	„ mutton „ potatoes ..	„ mutton „ barley broth.
10. Tuesday ..	„ beef .. „ „	„ beef .. „ pea-soup.
11. Wednesday	Salt beef .. „ pudding ..	Salt beef ...... „ pudding.
12. Thursday .	Fresh mutton „ vegetables .	Preserved mutton „ barley broth.
13. Friday ..	„ beef .. „ „	„ beef .. „ pea-soup.
14. Saturday .	„ mutton „ potatoes ..	„ mutton „ pudding.
	TROPICAL—WARM CLIMATES.	
	Harbour.	Sea.
1. Sunday ..	Fresh beef .. with potatoes ..	Preserved beef .. with rice.
2. Monday ..	„ mutton „ vegetables .	„ mutton „ barley broth.
3. Tuesday ..	„ beef .. „ rice	„ beef .. „ pudding.
4. Wednesday	Salt pork .. „ pea-soup ..	Salt pork ...... „ pea-soup.
5. Thursday .	Fresh mutton „ potatoes ..	Preserved mutton „ rice.
6. Friday ..	„ beef .. „ vegetables .	„ beef .. „ barley broth.
7. Saturday .	„ mutton „ rice	„ mutton „ pudding.
8. Sunday ..	Fresh beef .. with potatoes ..	Preserved beef .. with pea-soup.
9. Monday ..	„ mutton „ vegetables .	„ mutton „ rice.
10. Tuesday ..	„ beef .. „ rice	„ beef .. „ barley broth.
11. Wednesday	Salt beef .. „ pudding ..	Salt beef ...... „ pudding.
12. Thursday .	Fresh mutton „ potatoes ..	Preserved mutton „ pea-soup.
13. Friday ..	„ beef .. „ vegetables .	„ beef .. „ rice.
14. Saturday .	„ mutton „ rice	„ mutton „ barley broth.

Note.—The addition of rice to the temperate, sea- and harbour-dietaries during the summer months, and for the semi-tropical dietary, would make the rotation identical with that in the tropical scale.

The tropical and temperate scales here proposed contain no addition to the number of articles now or formerly in use in Her Majesty's Navy, either for the ordinary diet or use of the sick. Some are merely increased, others diminished or expunged from the list. Certain articles and quantities of the present have been adhered to in the proposed scale, and some altered; thus, the flour-pudding and pea-soup, which are healthful, palatable, and convenient for preservation, issue, and cooking, have been continued; also the fresh meat, vegetables, biscuit, tea, sugar, chocolate, lime-juice and condiments. Salt meat has been almost, and rum altogether, omitted; thus, the 1 lb. of salt has been replaced by ¾ lb. of preserved meat in temperate latitudes, and 8 oz. in the tropics, either equal in nutritive power to the former. Salt meat, recently and lightly pickled, might be issued once a week for change; given thus, less frequently and of better quality, it is unlikely to induce either debility or disease. The rum, already wisely and beneficially abandoned by a large part of the merchant service, might be replaced by coffee in temperate latitudes (a pleasant change from the morning cocoa and afternoon tea), and as this is heating, by lime-juice, in the tropics, both healthful antiscorbutic drinks. To make the diet less unvarying and more assimilative, the harbour ration of fresh beef may be alternated with mutton, and occasionally, perhaps pork, and succulent vegetables, with potatoes. Another pleasant innovation would be the alternation of the unvarying round of flour-pudding and pea-soup at sea, with barley broth and rice sweetened by molasses. Three changes may thus be given in temperate regions, and four in the tropics, where both appetite and digestion are capricious, and the need and craving for vegetable food greater. The occasional conversion of the potatoes and rice into soup, and roasting of the fresh beef and mutton, would give still greater variety.

The food required for tropical is identical with that for temperate latitudes, and only requires modification in quantity, as in the proposed scale, to suit the climate and frame. Those decreased in quantity are, the fresh meat in harbour, preserved meat at sea, and the coffee exchanged for lime-juice. On the other hand, the fresh vegetables, potatoes, flour-pudding, pea-soup, and other vegetable matters have been suitably increased. For a previously explained reason, the fresh and preserved meat for the tropics have not been reduced below 12 oz. of the one, and 8 oz. of the other. When necessary, a rice day may be added to the temperate dietary to form a useful intermediate scale, which we may term *semi-tropical*, fitted, for example, for the warm summer months of climates like that of England, but more especially for the debatable regions that lie between the wider hot and cool zones on either side of the equator, and the dry monsoon season along certain tropical coasts.

It is essential that the food selected for sea-dietaries be easily cooked. Though an elaborate cuisine be out of place, and for the most part impossible, on board ship, for men, still no object can be gained by keeping it of a primitive character, there being important motives, especially increased comfort, if not health, for improving it, at least for not limiting culinary efforts to invariable boiling. Why should not the fresh beef and mutton be occasionally roasted? And why might not a better class of cooks, and even cooking apparatus be acquired*?

* Like Benham's, now in use in the Herbert Hospital and (late) Royal Marine Infirmary at Woolwich.

The ordinary boiled form of preserved meat in air-tight tins still appears to rank first among its many younger rivals. That made at the Royal Victualling Yard at Deptford, though dearer, is decidedly superior to any yet submitted for comparison; and it deserves serious consideration whether it would not be better to continue the more costly article, made under Government supervision, than risk again creating a distaste for preserved meat, a casualty which might long prevent the permanent introduction of this great boon. As in harbour, different kinds, at least beef and mutton, should be given for variety. Pearl barley made into broth is a convenient and palatable addition to a sea-dietary, and rice, which nature, with singular significance, provides so lavishly in most warm regions; while, for the latter, treacle, which mixes and keeps well, is a convenient sweetener. Much of the vegetable matter (pease, flour, &c.) now issued is highly nitrogenous, and therefore well alternated with hydrocarbonaceous articles like rice. In the tropics, yams, very palatable when well cooked, and pumpkins, which make excellent soup, are good substitutes for the potatoes and vegetables of temperate latitudes. The frequent issue of soft bread, in harbour at least, especially in the tropics, would be both pleasant and salutary. With a diet of this kind, the issue of lime-juice in temperate latitudes might almost be dispensed with, or given only as a precautionary measure on long voyages. At sea, a half ration of chocolate issued to each man of the middle and morning watches, at their commencement, would stay their stomach, and prevent the ill effects which may result from the twelve to fourteen hours' fast between supper and breakfast, during which the system is often much tried by impure air, broken rest, meteorological vicissitudes, and other adverse agencies. Water, which can be distilled, and ought to be *issued* in as great purity on board ship as elsewhere, should not be stinted for drinking or culinary purposes; and it is a false economy which limits it for either. The quantity or quality of that supplied for cleanliness, though important, is a matter of far less moment, and need not be discussed here.

Those changes in the dieting of seamen would be in every way easy, the proposed nearly as uncomplicated as the present scales, and convenient from its easy adaptation to the many varieties of climate and season to which seamen are subjected in the temperate zone, in which they usually work, and tropics, where often sent; and the only argument which can with any fairness be urged against it is, that preserved meat is insipid, and its too frequent issue apt to make it distasteful. But while, on the one hand, it would be varied once or twice a week by salt meat, it is doubtful, on the other, if a prolonged diet of preserved meat of as good a quality as from Deptford, would be as unpalatable as a similar confinement to salt junk, especially if the food is otherwise sufficiently varied. Hitherto the innovation has been attended with satisfactory results in Her Majesty's Navy, the preserved meat being highly appreciated, and much in request; and the same result followed its former issue when good; while constant attention to the quality of the supply, and care in cooking, to make the preserved as far as possible resemble fresh provisions, would do much to diminish the danger of disgust.

The regulation of the change from the temperate to the tropical scale, or *vice versâ*, on entering or leaving either zone, which the adoption of

the proposed dietary implies, would be more easy than might be supposed. For though we cannot fairly judge of climate by latitude alone, and the old physical landmarks, the belts of Capricorn and Cancer will not serve our purpose, seeing that places geographically in the temperate zone may possess a sub-tropical or even tropical climate, and others in the tropics a semitemperate or temperate one, we may do so by heat. In the isotherms of 40° and 70° Fahr., we have a safe guide, inasmuch as all places with an average annual temperature above the latter may be considered as in the tropics, and all between the two in the temperate zone; and even the average temperature of any place for a few days, a week, month, or better still, its average annual temperature, would at once tell what scale, the tropical or temperate, should be used, or if the intermediate semi-tropical would be more appropriate. Uncertainty of this kind could only arise on the verge of the tropics, and where the climate is neither entirely tropical nor altogether temperate, or tropical during one portion of the year and temperate during the remainder. Well into either zone, and with a decidedly cool temperature on the one hand, or a confirmedly warm one on the other, there could be little hesitation; and in accordance therewith, the seaports of each station in the one, and those in the other, may be tabulated as follows (Table IV.), which might be made the rule, the index of the necessity for a change of diet. These scales would enable us to graduate the seamen's diet, from one suitable for the cold of an English winter, to one for the heat of the thermal equator; as during long voyages across the tropics, when the rapidly changing temperature and climate would be met by corresponding gradations in diet. Thus, leaving England, for example, on the ordinary temperate scale, the semi-tropical would be adopted on nearing, and continued till the torrid zone was fairly entered, for which the strictly tropical scale should be reserved. South of the equator the routine would, of course, be reversed. Although the alteration of diet in going to or coming from the tropics, according to the proposed scale, is not very great, chiefly one of relative quantity, and moreover salutary, and meant to meet the altered requirements of the system, we should thus lessen or altogether prevent the danger to health which might arise were this change made abruptly, by the institution of the intermediate or semi-tropical scale, which makes the process more gradual.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the various Seaports, &c. lie, Ports where Provisions are kept being printed in CAPITALS.

Stations, &c.		Extra-Tropical Part.		Tropical Part.	
		Limits.	Principal Seaports, &c. where Her Majesty's Ships Call.	Limits.	Principal Seaports, &c. where Her Majesty's Ships Call.
Temperate (Extra-Tropical)	Home	Altogether extra-tropical	PORTSMOUTH, PLYMOUTH, CHATHAM, &c.		
	Mediterranean	........ditto.......... (except the coasts of Tripoli and Barca, seldom visited).	MALTA, GIBRALTAR.		
Tropical	Coast of Africa....	....	....	Alogether tropical......	ASCENSION, SIERRA LEONE, &c.
	North America and West Indies.	From 30° N. lat. northward. (The North American part of the Station.)	BERMUDA, Bay of Fundy, HALIFAX, St. Johns, &c.	From its southern limit as far north as 30° N. lat. (The West Indian Division of the Station.)	Windward and Leeward Islands, Bahamas, JAMAICA, &c.; Ports along the Caribbean Sea and Gulf of Honduras (Maracaybo, Carthagena, Aspinwall, Greytown, Baliza); Gulf of Mexico and its Seaports (Vera Cruz, &c.)
	South America	From 25° S. lat. southward to Cape Horn.	MONTE-VIDEO, Buenos Ayres, Falkland Islands.	From its northern limit, where it adjoins the West Indies, to lat. 25° S.	Para, Maranhao, Pernambuco, Bahia, Rio Janeiro.
	Pacific	1. Northern part, to north of 28° N. lat. 2. Southern part, from 21° S. lat. to Cape Horn.	1. ESQUIMALT, San Francisco, &c. 2. Cobija, Caldera, Coquimbo, VALPARAISO, Valdivia, &c.	Between 28° N. lat. and 21° S. lat.	Guaymas, Mazatlan, S. Blas, Manzanilla, Acapulco, Panama, Guayaquil, Payta, CALLAO, Islay, Arica, Iquique.
Tropico-Temperate (partly Tropical and partly Extra-Tropical).	Cape of Good Hope and East Indies.	All the southern part of the African Coast to the southward of 28° S. lat. on the East, and of the Great Orange River on the West Coast.	Table Bay, SIMON'S BAY, Algoa Bay, Port Natal.	1. On the west side from the Orange River to S. lat. 2. On the E. side of the Cape, from S. lat. 28° n'thward. 3. Also all the Indian Coast as far as Singapore.	Ichaboe. Delagoa Bay, Quilimane, Mozambique, Zanzibar, Tamatave, Mauritius, Calcutta, Madras, Bombay, TRINCOMALEE, &c.
	China	The Station to the north of 28° N. lat.	Ningpo, SHANGHAE, Hangchu, Chusan, Chinkiang, Nankin, Tangchu, Tientsin, Nuchwang, &c. Nangasaki, YOKOHAMA, Hakodadi, &c.	The Station south of 28° N. lat.	Foochaufoo, Amoy, Swatow, HONG KONG, Whampoa, Canton, Kiangchow, Taiwan, Manilla, Singapore, Bankok.
	Australia	All that part of Australia which lies to the south of 23½ S. lat. on the East Coast, and 29° S. lat. on the West Coast.	Brisbane, SYDNEY, Melbourne, Hobart Town, New Zealand and its Settlements (AUCKLAND, Wellington, Nelson, &c.)	That part which lies to the north of 23½ S. lat. on the East Coast, and 29° S. lat. on its West Coast	Rockhampton, Gladstone, Port Denison, Cardwell, Somerset. Islands in the South Seas (Figis, &c.)

HYGEIA

A CITY OF HEALTH

BY

BENJAMIN WARD RICHARDSON
M.D., F.R.S.

London
MACMILLAN AND CO.
1876

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	EXTRA-TROPICAL PART.	TROPICAL PART.
Temperate (Extra-Tropical)		
Tropical		
Tropico-temperate (partly Tropical and partly Extra-Tropical)		

TO

EDWIN CHADWICK, C.B.

MY DEAR MR. CHADWICK,

I wrote this Address with the intention of dedicating it to you, as a simple but hearty acknowledgment by a sanitary student, himself well ripened in the work, of your pre-eminent position as the living leader of the sanitary reformation of this century.

The favour the Address has received indicates notably two facts: the advance of public opinion on the subject of public health, and the remarkable value and influence of your services as the sanitary statesman by whom that opinion has been so wisely formed and directed.

In this sense of my respect for you, and of my gratitude, pray accept this trifling recognition, and believe me to be,

Ever faithfully yours,

B. W. RICHARDSON.

McGILL & WITHEROW, PRINTERS.
1861.

PREFATORY NOTE.

THE immediate success of this Address caused me to lay it aside for some months, to see if the favour with which it was received would remain. I am satisfied to find that the good fortune which originally attended the effort holds on, and that in publishing it now in a separate form I am acting in obedience to a generally expressed desire.

Since the delivery of the Address before the Health Department of the Social Science Congress, over which I had the honour to preside, at Brighton, in October last, every day has brought some new suggestion bearing on the subjects discussed, and the temptation has been great to add new matter, or even to recast the essay and bring it out as a more compendious work. On reflection I prefer to let it take its place in literature, in the first instance, in its original and simple dress.

12 HINDE STREET, W.:
August 18, 1876.

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HYGEIA,

A

CITY OF HEALTH

WE meet in this Assembly, a voluntary Parliament of men and women, to study together and to exchange knowledge and thought on works of every-day life and usefulness. Our object, to make the present existence better and happier; to inquire, in this particular section of our Congress:—What are the conditions which lead to the pain and penalty of disease; what the means for the removal of those conditions when they are discovered? What are the most ready and convincing methods of making known to the uninformed the facts: that many of the conditions are under our control; that neither mental serenity nor mental development can exist with an unhealthy animal organisation; that poverty is the shadow of disease, and wealth the shadow of health?

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These objects relate to ourselves, to our own reliefs from suffering, to our own happiness, to our own riches. We have, I trust and believe, yet another object, one that relates not to ourselves, but to those who have yet to be; those to whom we may become known, but whom we can never know, who are the ourselves, unseen to ourselves, continuing our mission.

We are privileged more than any who have as yet lived on this planet in being able to foresee, and in some measure estimate, the results of our wealth of labour as it may be possibly extended over and through the unborn. A few scholars of the past, like him who, writing to the close of his mortal day, sang himself to his immortal rest with the '*Gloria in excelsis*,' a few scholars might foresee, even as that Bæda did, that their living actual work was but the beginning of their triumphant course through the ages,—the momentum. But the masses of the nations, crude and selfish, have had no such prescience, no such intent. 'Let us eat and drink, for to-morrow we die!' That has been the pass, if not the password, with them and theirs.

We, scholars of modern thought, have the broader, and therefore more solemn and obligatory knowledge, that however many to-morrows may come, and whatever fate they may bring, we never

die; that, strictly speaking, no one yet who has lived has ever died; that for good or for evil our every change from potentiality into motion is carried on beyond our own apparent transitoriness; that we are the waves of the ocean of life, communicating motion to the expanse before us, and leaving the history we have made on the shore behind.

Thus we are led to feel this greater object: that to whatever extent we, by our exertions, confer benefits on those who live, we extend the advantage to those who have to live; that one good thought leading to practical useful action from one man or woman, may go to the virtue of thousands of generations; that one breath of health wafted by our breath may, in the aggregate of life saved by it, represent in its ultimate effect all the life that now is or has been.

At the close of a Parliamentary session, an uneventful leader of a section of Parliament banters his more eventful rival, and enlivening his criticism by a sneer at our Congress, challenges the contempt of his rival, as if to draw it forth in the same critical direction. Alas! it is too true that great congresses, like great men, and even like Parliaments, do live sometimes for many years and talk much, and seem to miss much and advance little;

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so that in what relates to the mere present it were wrong, possibly, to challenge the sally of the statesman who, from his own helpless height, looked down on our weakness. But inasmuch as no man knoweth the end of the spoken word, as that which is spoken to-day, earnestly and simply, may not reappear for years, and may then appear with force and quality of hidden virtue, there is reason for our uniting together beyond the proof of necessity which is given in the fact of our existence. Perchance some day our natural learning, gathered in our varied walks of life, and submitted in open council, may survive even Parliamentary strife; perchance our resolutions, though no sign-manual immediately grace them, are the informal bills which ministers and oppositions shall one day discuss, Parliaments pass, royal hands sign, and the fixed administrators of the will of the nation duly administer.

These thoughts on the future, rather than on the passing influence of our congressional work, have led me to the simple design of the address which, as President of this Section, I venture to submit to you to-day. It is my object to put forward a theoretical outline of a community so circumstanced and so maintained by the exercise of its own freewill, guided by scientific knowledge, that in it the perfection of sanitary results will be

approached, if not actually realised, in the co-existence of the lowest possible general mortality with the highest possible individual longevity. I shall try to show a working community in which death,—if I may apply so common and expressive a phrase on so solemn a subject,—is kept as nearly as possible in its proper or natural place in the scheme of life.

HEALTH AND CIVILISATION.

Before I proceed to this task, it is right I should ask of the past what hope there is of any such advancement of human progress. For, as my Lord of Verulam quaintly teaches, 'the past ever deserves that men should stand upon it for awhile to see which way they should go, but when they have made up their minds they should hesitate no longer, but proceed with cheerfulness.' For a moment, then, we will stand on the past.

From this vantage-ground we gather the fact, that onward with the simple progress of true civilisation the value of life has increased. Ere yet the words 'Sanitary Science' had been written; ere yet the heralds of that science (some of whom, in the persons of our illustrious colleagues, Edwin Chadwick and William Farr, are with us in this place at this moment), ere yet these heralds had

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Temperate (Extra-Tropical) Tropical .... Tropico-Temperate (partly Tropical and partly Extra-Tropical)

summoned the world to answer for its profligacy of life, the health and strength of mankind was undergoing improvement. One or two striking facts must be sufficient in the brief space at my disposal to demonstrate this truth. In England, from 1790 to 1810, Heberden calculated that the general mortality diminished one-fourth. In France, during the same period, the same favourable returns were made. The deaths in France, Berard calculated, were 1 in 30 in the year 1780, and during the eight years, from 1817 to 1828, 1 in 40, or a fourth less. In 1780, out of 100 new-born infants, in France, 50 died in the two first years; in the later period, extending from the time of the census that was taken in 1817 to 1827, only 38 of the same age died, an augmentation of infant life equal to 25 per cent. In 1780 as many as 55 per cent. died before reaching the age of ten years; in the later period 43, or about a fifth less. In 1780 only 21 persons per cent. attained the age of 50 years; in the later period 32, or eleven more, reached that term. In 1780 but 15 persons per cent. arrived at 60 years; in the later period 24 arrived at that age.

Side by side with these facts of the statist we detect other facts which show that in the progress of civilisation the actual organic strength and build

of the man and woman increases. As in the highest developments of the fine arts the sculptor and painter place before us the finest imaginative types of strength, grace, and beauty, so the silent artist, civilisation, approaches nearer and nearer to perfection, and by evolution of form and mind developes what is practically a new order of physical and mental build. Peron,—who first used, if he did not invent, the little instrument, the dynamometer, or muscular-strength measurer,—subjected persons of different stages of civilisation to the test of his gauge, and discovered that the strength of the limbs of the natives of Van Diemen's Land and New Holland was as 50 degrees of power, while that of the Frenchmen was 69, and of the Englishmen 71. The same order of facts are maintained in respect to the size of body. The stalwart Englishman of to-day can neither get into the armour nor be placed in the sarcophagus of those sons of men who were accounted the heroes of the infantile life of the human world.

We discover, moreover, from our view of the past, that the developments of tenacity of life and of vital power have been comparatively rapid in their course when they have once commenced. There is nothing discoverable to us that would lead to the conception of a human civilisation

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extending back over two hundred generations; and when in these generations we survey the actual effect of civilisation, so fragmentary and overshadowed by persistent barbarism, in influencing disease and mortality, we are reduced to the observation of at most twelve generations, including our own, engaged, indirectly or directly, in the work of sanitary progress. During this comparatively brief period, the labour of which, until within a century, has had no systematic direction, the changes for good that have been effected are amongst the most startling of historical facts. Pestilences which decimated populations, and which, like the great plague of London, destroyed 7,165 people in a single week, have lost their virulency; gaol fever has disappeared, and our gaols, once each a plague-spot, have become, by a strange perversion of civilisation, the health spots of, at least, one kingdom. The term, Black Death, is heard no more; and ague, from which the London physician once made a fortune, is now a rare tax even on the skill of the hardworked Union Medical Officer.

From the study of the past we are warranted, then, in assuming that civilisation, unaided by special scientific knowledge, reduces disease and lessens mortality, and that the hope of doing still more by systematic scientific art is fully justified.

I might hereupon proceed to my project straightway. I perceive, however, that it may be urged, that as mere civilising influences can of themselves effect so much, they might safely be left to themselves to complete, through the necessity of their demands, the whole sanitary code. If this were so, a formula for a city of health were practically useless. The city would come without the special call for it.

I think it probable the city would come in the manner described, but how long it would be coming is hard to say, for whatever great results have followed civilisation, the most that has occurred has been an unexpected, unexplained, and therefore uncertain arrest of the spread of the grand physical scourges of mankind. The phenomena have been suppressed, but the root of not one of them has been touched. Still in our midst are thousands of enfeebled human organisms which only are comparable with the savage. Still are left amongst us the bases of all the diseases that, up to the present hour, have afflicted humanity.

The existing calendar of diseases, studied in connection with the classical history of the diseases written for us by the longest unbroken line of authorities in the world of letters, shows, in unmistakable language, that the imposition of every known malady

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of man is coeval with every phase of his recorded life on the planet. No malady, once originated, has ever actually died out; many remain as potent as ever. That wasting fatal scourge, pulmonary consumption, is the same in character as when Cœlius Aurelianus gave it description. The cancer of to-day is the cancer known to Paulus Eginæta. The Black Death, though its name is gone, lingers in malignant typhus. The great plague of Athens is the modern great plague of England, scarlet fever. The dancing mania of the Middle Ages and the convulsionary epidemic of Montmartre, subdued in their violence, are still to be seen in some American communities, and even at this hour in the New Forest of England. Small-pox, when the blessed protection of vaccination is withdrawn, is the same virulent destroyer as it was when the Arabian Rhazes defined it. Ague lurks yet in our own island, and, albeit the physician is not enriched by it, is in no symptom changed from the ague that Celsus knew so well. Cholera, in its modern representation is more terrible a malady than its ancient type, in so far as we have knowledge of it from ancient learning. And that fearful scourge, the great plague of Constantinople, the plague of hallucination and convulsion which raged in the Fifth Century of our era, has in our time, under the new

names of tetanoid fever and cerebro-spinal meningitis, been met with here and in France, and in Massachusetts has, in the year 1873, laid 747 victims in the dust.

I must cease these illustrations, though I could extend them fairly over the whole chapter of disease, past and present. Suffice it if I have proved the general propositions, that disease is now as it was in the beginning, except that in some examples of it it is less virulent; that the science for extinguishing any one disease has yet to be learned; that, as the bases of disease exist, untouched by civilisation, so the danger of disease is ever imminent, unless we specially provide against it; that the development of disease may occur with original virulence and fatality, and may at any moment be made active under accidental or systematic ignorance.

A CITY OF HEALTH.

I now come to the design I have in hand. Mr. Chadwick has many times told us that he could build a city that would give any stated mortality, from fifty, or any number more, to five, or perhaps some number less, in the thousand annually. I believe Mr. Chadwick to be correct to the letter in this statement, and for that reason I have projected a city that shall show the lowest mortality. I need not say that no such city exists, and you must pardon me for drawing upon your imaginations as I describe it. Depicting nothing whatever but what is at this present moment easily possible, I shall strive to bring into ready and agreeable view a community not abundantly favoured by natural resources, which, under the direction of the scientific knowledge acquired in the past two generations, has attained a vitality not perfectly natural, but approaching to that standard. In an artistic sense it would have been better to have chosen a small town or large village than a city for my description; but as the great mortality of States is resident in cities, it is practically better to take the larger and less favoured community. If cities could be transformed, the rest would follow.

Our city, which may be named *Hygeia*, has the advantage of being a new foundation, but it is so built that existing cities might be largely modelled upon it.

The population of the city may be placed at 100,000, living in 20,000 houses, built on 4,000 acres of land,—an average of 25 persons to an acre. This may be considered a large population for the space occupied, but, since the effect of density on vitality tells only determinately when it reaches a

certain extreme degree, as in Liverpool and Glasgow, the estimate may be ventured.

The safety of the population of the city is provided for against density by the character of the houses, which ensures an equal distribution of the population. Tall houses overshadowing the streets, and creating necessity for one entrance to several tenements, are nowhere permitted. In streets devoted to business, where the tradespeople require a place of mart or shop, the houses are four stories high, and in some of the western streets where the houses are separate, three and four storied buildings are erected; but on the whole it is found bad to exceed this range, and as each story is limited to 15 feet, no house is higher than 60 feet.

The substratum of the city is of two kinds. At its northern and highest part, there is clay; at its southern and south-eastern, gravel. Whatever disadvantages might spring in other places from a retention of water on a clay soil, is here met by the plan that is universally followed, of building every house on arches of solid brickwork. So, where in other towns there are areas, and kitchens, and servants' offices, there are here subways through which the air flows freely, and down the inclines of which all currents of water are carried away.

The acreage of our model city allows room for

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three wide main streets or boulevards, which run from east to west, and which are the main thoroughfares. Beneath each of these is a railway along which the heavy traffic of the city is carried on. The streets from north to south which cross the main thoroughfares at right angles, and the minor streets which run parallel, are all wide, and, owing to the lowness of the houses, are thoroughly ventilated, and in the day are filled with sunlight. They are planted on each side of the pathways with trees, and in many places with shrubs and evergreens. All the interspaces between the backs of houses are gardens. The churches, hospitals, theatres, banks, lecture-rooms, and other public buildings, as well as some private buildings such as warehouses and stables, stand alone, forming parts of streets, and occupying the position of several houses. They are surrounded with garden space, and add not only to the beauty but to the healthiness of the city. The large houses of the wealthy are situated in a similar manner.

The streets of the city are paved throughout with the same material. As yet wood pavement set in asphalte has been found the best. It is noiseless, cleanly, and durable. Tramways are nowhere permitted, the system of underground railways being found amply sufficient for all purposes. The

side pavements, which are everywhere ten feet wide, are of white or light grey stone. They have a slight incline towards the streets, and the streets have an incline from their centres towards the margins of the pavements.

From the circumstance that the houses of our model city are based on subways, there is no difficulty whatever in cleansing the streets, no more difficulty than is experienced in Paris. That disgrace to our modern civilisation, the mud cart, is not known, and even the necessity for Mr. E. H. Bayley's roadway moveable tanks for mud sweepings,—so much wanted in London and other towns similarly built,—does not exist. The accumulation of mud and dirt in the streets is washed away every day through side openings into the subways, and is conveyed, with the sewage, to a destination apart from the city. Thus the streets everywhere are dry and clean, free alike of holes and open drains. Gutter children are an impossibility in a place where there are no gutters for their innocent delectation. Instead of the gutter, the poorest child has the garden; for the foul sight and smell of unwholesome garbage, he has flowers and green sward.

It will be seen, from what has been already told, that in this our model city there are no underground cellars, kitchens, or other caves, which, worse than those ancient British caves that Nottingham still can show the antiquarian as the once fastnesses of her savage children, are even now the loathsome residences of many millions of our domestic and industrial classes. There is not permitted to be one room underground. The living part of every house begins on the level of the street. The houses are built of a brick which has the following sanitary advantages:—It is glazed, and quite impermeable to water, so that during wet seasons the walls of the houses are not saturated with tons of water, as is the case with so many of our present residences. The bricks are perforated transversely, and at the end of each there is a wedge opening, into which no mortar is inserted, and by which all the openings are allowed to communicate with each other. The walls are in this manner honeycombed, so that there is in them a constant body of common air let in by side openings in the outer wall, which air can be changed at pleasure, and, if required, can be heated from the firegrates of the house. The bricks intended for the inside walls of the house, those which form the walls of the rooms, are glazed in different colours, according to the taste of the owner, and are laid so neatly, that the after adornment of the walls is considered unnecessary, and, indeed, objectionable. By this

means those most unhealthy parts of household accommodation, layers of mouldy paste and size, layers of poisonous paper, or layers of absorbing colour stuff or distemper, are entirely done away with. The walls of the rooms can be made clean at any time by the simple use of water, and the ceilings, which are turned in light arches of thinner brick, or tile, coloured to match the wall, are open to the same cleansing process. The colour selected for the inner brickwork is grey, as a rule, that being most agreeable to the sense of sight; but various tastes prevail, and art so soon ministers to taste, that, in the houses of the wealthy, delightful patterns of work of Pompeian elegance are soon introduced.

As with the bricks, so with the mortar and the wood employed in building, they are rendered, as far as possible, free of moisture. Sea sand containing salt, and wood that has been saturated with sea water, two common commodities in badly built houses, find no place in our modern city.

The most radical changes in the houses of our city are in the chimneys, the roofs, the kitchens, and their adjoining offices. The chimneys, arranged after the manner proposed by Mr. Spencer Wells, are all connected with central shafts, into which the smoke is drawn, and, after being passed through a

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gas furnace to destroy the free carbon, is discharged colourless into the open air. The city, therefore, at the expense of a small smoke rate, is free of raised chimneys and of the intolerable nuisance of smoke. The roofs of the houses are but slightly arched, and are indeed all but flat. They are covered either with asphalte, which experience, out of our supposed city, has proved to last long and to be easily repaired, or with flat tile. The roofs, barricaded round with iron palisades, tastefully painted, make excellent outdoor grounds for every house. In some instances flowers are cultivated on them.

The housewife must not be shocked when she hears that the kitchens of our model city, and all the kitchen offices, are immediately beneath these garden roofs; are, in fact, in the upper floor of the house instead of the lower. In every point of view, sanitary and economical, this arrangement succeeds admirably. The kitchen is lighted to perfection, so that all uncleanliness is at once detected. The smell which arises from cooking is never disseminated through the rooms of the house. In conveying the cooked food from the kitchen, in houses where there is no lift, the heavy weighted dishes have to be conveyed down, the emptied and lighter dishes upstairs. The hot water from the kitchen boiler is distributed easily by conducting pipes into the lower

rooms, so that in every room and bedroom hot and cold water can at all times be obtained for washing or cleaning purposes; and as on every floor there is a sink for receiving waste water, the carrying of heavy pails from floor to floor is not required. The scullery, which is by the side of the kitchen, is provided with a copper and all the appliances for laundry work; and when the laundry work is done at home the open place on the roof above makes an excellent drying ground.

In the wall of the scullery is the upper opening to the dust-bin shaft. This shaft, open to the air from the roof, extends to the bin under the basement of the house. A sliding door in the wall opens into the shaft to receive the dust, and this plan is carried out on every floor. The coal-bin is off the scullery, and is ventilated into the air through a separate shaft, which also passes through the roof.

On the landing in the second or middle stories of the three-storied houses there is a bathroom, supplied with hot and cold water from the kitchen above. The floor of the kitchen and of all the upper stories is slightly raised in the centre, and is of smooth, grey tile; the floor of the bath-room is the same. In the living-rooms, where the floors are of wood, a true oak margin of floor extends two feet around each room. Over this no carpet is ever

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laid. It is kept bright and clean by the old-fashioned bees'-wax and turpentine, and the air is made fresh and is ozonised by the process.

Considering that a third part of the life of man is, or should be, spent in sleep, great care is taken with the bed-rooms, so that they shall be thoroughly lighted, roomy, and ventilated. Twelve hundred cubic feet of space is allowed for each sleeper, and from the sleeping apartments all unnecessary articles of furniture and of dress are rigorously excluded. Old clothes, old shoes, and other offensive articles of the same order, are never permitted to have residence there. In most instances the rooms on the first floor are made the bed-rooms, and the lower the living-rooms. In the larger houses bed-rooms are carried out in the upper floor for the use of the domestics.

To facilitate communication between the kitchen and the entrance-hall, so that articles of food, fuel, and the like may be carried up, a shaft runs in the partition between two houses, and carries a basket lift in all houses that are above two stories high. Every heavy thing to and from the kitchen is thus carried up and down from floor to floor and from the top to the basement, and much unnecessary labour is thereby saved. In the two-storied houses the lift is unnecessary. A flight of outer steps leads to the upper or kitchen floor.

The warming and ventilation of the houses is carried out by a common and simple plan. The cheerfulness of the fireside is not sacrificed; there is still the open grate in every room, but at the back of the firestove there is an air-box or case which, distinct from the chimney, communicates by an opening with the outer air, and by another opening with the room. When the fire in the room heats the iron receptacle, fresh air is brought in from without, and is diffused into the room at the upper part on a plan similar to that devised by Captain Galton.

As each house is complete within itself in all its arrangements, those disfigurements called back premises are not required. There is a wide space consequently between the back fronts of all houses, which space is, in every instance, turned into a garden square, kept in neat order, ornamented with flowers and trees, and furnished with playgrounds for children, young and old.

The houses being built on arched subways, great convenience exists for conveying sewage from, and for conducting water and gas into, the different domiciles. All pipes are conveyed along the subways, and enter each house from beneath. Thus the mains of the water pipe and the mains of the gas are within instant control on the first floor of the building, and a leakage from either can be immediately prevented. The officers who supply the commodities of gas and water have admission to the subways, and find it most easy and economical to keep all that is under their charge in perfect repair. The sewers of the houses run along the floors of the subways, and are built in brick. They empty into three cross main sewers. They are trapped for each house, and as the water supply is continuous, they are kept well flushed. In addition to the house flushings there are special openings into the sewers by which, at any time, under the direction of the sanitary officer, an independent flushing can be carried out. The sewers are ventilated into tall shafts from the mains by means of a pneumatic engine.

The water-closets in the houses are situated on the middle and basement floors. The continuous water-supply flushes them without danger of charging the drinking water with gases emanating from the closet; a danger so imminent in the present method of cisterns, which supply drinking as well as flushing water.

As we walk the streets of our model city, we notice an absence of places for the public sale of spirituous liquors. Whether this be a voluntary purgation in goodly imitation of the National Tem-

perance League, the effect of Sir Wilfrid Lawson's Permissive Bill and most permissive wit and wisdom, or the work of the Good Templars, we need not stay to inquire. We look at the fact only. To this city, as to the town of St. Johnsbury, in Vermont, which Mr. Hepworth Dixon has so graphically described, we may apply the description Mr. Dixon has written: 'No bar, no dram shop, no saloon defiles the place. Nor is there a single gaming hell or house of ill-repute.' Through all the workshops into which we pass, in whatever labour the men or women may be occupied,—and the place is noted for its manufacturing industry,—at whatever degree of heat or cold, strong drink is unknown. Practically, we are in a total abstainers' town, and a man seen intoxicated would be so avoided by the whole community, he would have no peace to remain.

And, as smoking and drinking go largely together, as the two practices were, indeed, original exchanges of social degradations between the civilised man and the savage, the savage getting very much the worst of the bargain, so the practices largely disappear together. Pipe and glass, cigar and sherry-cobbler, like the Siamese twins, who could only live connected, have both died out in our model city. Tobacco, by far the most innocent

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partner of the firm, lived, as it perhaps deserved to do, a little the longest; but it passed away, and the tobacconist's counter, like the dram counter, has disappeared.

The streets of our city, though sufficiently filled with busy people, are comparatively silent. The subways relieve the heavy traffic, and the factories are all at short distances from the town, except those in which the work that is carried on is silent and free from nuisance. This brings me to speak of some of the public buildings which have relation to our present studies.

It has been found in our towns, generally, that men and women who are engaged in industrial callings, such as tailoring, shoe-making, dress-making, lace-work and the like, work at their own homes amongst their children. That this is a common cause of disease is well understood. I have myself seen the half-made riding-habit that was ultimately to clothe some wealthy damsel rejoicing in her morning ride act as the coverlet of a poor tailor's child stricken with malignant scarlet fever. These things must be, in the ordinary course of events under our present bad sanitary system. In the model city we have in our mind's eye, these dangers are met by the simple provision of workmen's offices or workrooms. In convenient parts of

the town there are blocks of buildings, designed mainly after the manner of the houses, in which each workman can have a work-room on payment of a moderate sum per week. Here he may work as many hours as he pleases, but he may not transform the room into a home. Each block is under the charge of a superintendent, and also under the observation of the sanitary authorities. The family is thus separated from the work, and the working man is secured the same advantages as the lawyer, the merchant, the banker now possesses: or to make the parallel more correct, he has the same advantage as the man or woman who works in a factory, and goes home to eat and to sleep.

In most towns throughout the kingdom the laundry system is dangerous in the extreme. For anything the healthy householder knows, the clothes he and his children wear have been mixed before, during, and after the process of washing, with the clothes that have come from the bed or the body of some sufferer from a contagious malady. Some of the most fatal outbreaks of disease I have met with have been communicated in this manner. In our model community this danger is entirely avoided by the establishment of public laundries, under municipal direction. No

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person is obliged to send any article of clothing to be washed at the public laundry; but if he does not send there he must have the washing done at home. Private laundries that do not come under the inspection of the sanitary officer are absolutely forbidden. It is incumbent on all who send clothes to the public laundry from an infected house to state the fact. The clothes thus received are passed for special cleansing into the disinfecting rooms. They are specially washed, dried, and prepared for future wear. The laundries are placed in convenient positions, a little outside the town; they have extensive drying grounds, and, practically, they are worked so economically, that home-washing days, those invaders of domestic comfort and health, are abolished.

Passing along the main streets of the city we see in twenty places, equally distant, a separate building surrounded by its own grounds,—a model hospital for the sick. To make these institutions the best of their kind, no expense is spared. Several elements contribute to their success. They are small, and are readily removable. The old idea of warehousing diseases on the largest possible scale, and of making it the boast of an institution that it contains so many hundred beds, is abandoned here. The old idea of building an institution so

that it shall stand for centuries, like a Norman castle, but, unlike the castle, still retain its original character as a shelter for the afflicted, is abandoned here. The still more absurd idea of building hospitals for the treatment of special organs of the body, as if the different organs could walk out of the body and present themselves for treatment, is also abandoned.

It will repay us a minute of time to look at one of these model hospitals. One is the *fac simile* of the other, and is devoted to the service of every five thousand of the population. Like every building in the place, it is erected on a subway. There is a wide central entrance, to which there is no ascent, and into which a carriage, cab, or ambulance can drive direct. On each side the gateway are the houses of the resident medical officer and of the matron. Passing down the centre, which is lofty and covered in with glass, we arrive at two sidewings running right and left from the centre, and forming cross-corridors. These are the wards: twelve on one hand for male, twelve on the other for female patients. The cross-corridors are twelve feet wide and twenty feet high, and are roofed with glass. The corridor on each side is a framework of walls of glazed brick, arched over head, and divided into six segments. In each segment is a

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separate, light, elegant removable ward, constructed of glass and iron, twelve feet high, fourteen feet long, and ten feet wide. The cubic capacity of each ward is 1,680 feet. Every patient who is ill enough to require constant attendance has one of these wards entirely to himself, so that the injurious influences on the sick, which are created by mixing up, in one large room, the living and the dying; those who could sleep, were they at rest, with those who cannot sleep, because they are racked with pain; those who are too nervous or sensitive to move, or cough, or speak, lest they should disturb others; and those who do whatever pleases them:—these bad influences are absent.

The wards are fitted up neatly and elegantly. At one end they open into the corridor, at the other towards a verandah which leads to a garden. In bright weather those sick persons, who are even confined to bed, can, under the direction of the doctor, be wheeled in their beds out into the gardens without leaving the level floor. The wards are warmed by a current of air made to circulate through them by the action of a steam-engine, with which every hospital is supplied, and which performs such a number of useful purposes, that the wonder is, how hospital management could go on without the engine.

If at any time a ward becomes infectious, it is removed from its position and is replaced by a new ward. It is then taken to pieces, disinfected, and laid by ready to replace another that may require temporary ejection.

The hospital is supplied on each side with ordinary baths, hot-air baths, vapour baths, and saline baths.

A day sitting-room is attached to each wing, and every reasonable method is taken for engaging the minds of the sick in agreeable and harmless pastimes.

Two trained nurses attend to each corridor, and connected with the hospital is a school for nurses, under the direction of the medical superintendent and the matron. From this school, nurses are provided for the town; they are not merely efficient for any duty in the vocation in which they are always engaged, either within the hospital or out of it, but from the care with which they attend to their own personal cleanliness, and the plan they pursue of changing every garment on leaving an infectious case, they fail to be the bearers of any communicable disease. To one hospital four medical officers are appointed, each of whom, therefore, has six resident patients under his care. The officers are called simply medical officers, the distinction,

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now altogether obsolete, between physicians and surgeons being discarded.

The hospital is brought, by an electrical wire, into communication with all the fire-stations, factories, mills, theatres, and other important public places. It has an ambulance always ready to be sent out to bring any injured persons to the institution. The ambulance drives straight into the hospital, where a bed of the same height on silent wheels, so that it can be moved without vibration into a ward, receives the patient.

The kitchens, laundries, and laboratories are in a separate block at the back of the institution, but are connected with it by the central corridor. The kitchen and laundries are at the top of this building, the laboratories below. The disinfecting-room is close to the engine-room, and superheated steam, which the engine supplies, is used for disinfection.

The out-patient department, which is apart from the body of the hospital, resembles that of the Queen's Hospital, Birmingham,—the first out-patient department, as far as I am aware, that ever deserved to be seen by a generous public. The patients waiting for advice are seated in a large hall, warmed at all seasons to a proper heat, lighted from the top through a glass roof, and perfectly ventilated. The infectious cases are sepa-

rated carefully from the rest. The consulting rooms of the medical staff are comfortably fitted, the dispensary is thoroughly officered, and the order that prevails is so effective that a sick person, who is punctual to time, has never to wait.

The medical officers attached to the hospital in our model city are allowed to hold but one appointment at the same time, and that for a limited period. Thus every medical man in the city obtains the equal advantage of hospital practice, and the value of the best medical and surgical skill is fairly equalised through the whole community.

In addition to the hospital building is a separate block, furnished with wards, constructed in the same way as the general wards, for the reception of children suffering from any of the infectious diseases. These wards are so planned that the people, generally, send sick members of their own family into them for treatment, and pay for the privilege.

Supplementary to the hospital are certain other institutions of a kindred character. To check the terrible course of infantile mortality of other large cities,—the 76 in the 1,000 of mortality under five years of age, homes for little children are abundant. In these the destitute young are carefully tended by intelligent nurses; so that mothers, while

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following their daily callings, are enabled to leave their children under efficient care.

In a city from which that grand source of wild mirth, hopeless sorrow and confirmed madness, alcohol, has been expelled, it could hardly be expected that much insanity would be found. The few who are insane are placed in houses licensed as asylums, but not different in appearance to other houses in the city. Here the insane live, in small communities, under proper medical supervision, with their own gardens and pastimes.

The houses of the helpless and aged are, like the asylums, the same as the houses of the rest of the town. No large building of pretentious style uprears itself for the poor; no men badged and badgered as paupers walk the place. Those poor who are really, from physical causes, unable to work, are maintained in a manner showing that they possess yet the dignity of human kind; and that, being worth preservation, they are therefore worthy of respectful tenderness. The rest, those who can work, are employed in useful labours, which pay for their board. If they cannot find work, and are deserving, they may lodge in the house and earn their subsistence; or they may live from the house and receive pay for work done. If they will not work, they, as vagrants, find a home in prison,

where they are compelled to share the common lot of mankind.

Our model city is of course well furnished with baths, swimming baths, Turkish baths, playgrounds, gymnasia, libraries, board schools, fine art schools, lecture halls, and places of instructive amusement. In every board-school drill forms part of the programme. I need not dwell on these subjects, but must pass to the sanitary officers and offices.

There is in the city one principal sanitary officer, a duly qualified medical man elected by the Municipal Council, whose sole duty it is to watch over the sanitary welfare of the place. Under him, as sanitary officers, are all the medical men who form the poor law medical staff. To him these make their reports on vaccination and every matter of health pertaining to their respective districts; to him every registrar of births and deaths forwards copies of his registration returns; and to his office are sent, by the medical men generally, registered returns of the cases of sickness prevailing in the district. His inspectors likewise make careful returns of all the known prevailing diseases of the lower animals and of plants. To his office are forwarded, for examination and analysis, specimens of foods and drinks suspected to be adulterated, impure, or otherwise unfitted for use. For the conduction of these researches the sanitary superintendent is allowed a competent chemical staff. Thus, under this central supervision, every death, every disease of the living world in the district, and every assumable cause of disease, comes to light and is subjected, if need be, to inquiry.

At a distance from the town are the sanitary works, the sewage pumping works, the water and gas works, the slaughter-houses and the public laboratories. The sewage, which is brought from the town partly by its own flow and partly by pumping apparatus, is conveyed away to well-drained sewage farms belonging to, but at a distance from, the city where it is utilised.

The water supply, derived from a river which flows to the south-west of the city, is unpolluted by sewage or other refuse, is carefully filtered, is tested twice daily, and if found unsatisfactory is supplied through a reserve tank, after it has been made to undergo further purification. It is carried through the city everywhere by iron pipes. Leaden pipes are forbidden. In the sanitary establishment are disinfecting rooms, a mortuary, and ambulances for the conveyance of persons suffering from contagious disease. These are at

all times open to the use of the public, subject to the few and simple rules of the management.

The gas, like the water, is submitted to regular analysis by the staff of the sanitary officer, and any fault which may be detected, and which indicates a departure from the standard of purity framed by the Municipal Council, is immediately remedied, both gas and water being exclusively under the control of the local authority.

The inspectors of the sanitary officer have under them a body of scavengers. These, each day, in the early morning, pass through the various districts allotted to them, and remove all refuse in closed vans. Every portion of manure from stables, streets, and yards is in this way removed daily, and transported to the city farms for utilisation.

Two additional conveniences are supplied by the scientific work of the sanitary establishment. From steam-works steam is condensed, and a large supply of distilled water is obtained and preserved in a separate tank. This distilled water is conveyed by a small main into the city, and is supplied at a moderate cost for those domestic purposes for which hard water is objectionable.

The second sanitary convenience is a large ozone generator. By this apparatus ozone is produced in any required quantity, and is made to play

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many useful purposes. It is passed through the drinking water in the reserve reservoir whenever the water shows excess of organic impurity, and it is conveyed into the city for diffusion into private houses, for purposes of disinfection.

The slaughter-houses of the city are all public, and are separated by a distance of a quarter of a mile from the city. They are easily removable edifices, and are under the supervision of the sanitary staff. The Jewish system of inspecting every carcase that is killed is rigorously carried out, with this improvement, that the inspector is a man of scientific knowledge.

All animals used for food,—cattle, fowls, swine, rabbits,—are subjected to examination in the slaughter-house, or in the market, if they be brought into the city from other depôts. The slaughter-houses are so constructed that the animals killed are relieved from the pain of death. They pass through a narcotic chamber, and are brought to the slaughterer oblivious of their fate. The slaughter-houses drain into the sewers of the city, and their complete purification daily, from all offal and refuse, is rigidly enforced.

The buildings, sheds, and styes for domestic food-producing animals are removed a short distance from the city, and are also under the supervision of

the sanitary officer; the food and water supplied for these animals comes equally, with human food, under proper inspection.

One other subject only remains to be noticed in connection with the arrangements of our model city, and that is the mode of the disposal of the dead. The question of cremation and of burial in the earth has been considered, and there are some who advocate cremation. For various reasons the process of burial is still retained. Firstly, because the cremation process is open to serious medico-legal objections; secondly, because, by the complete resolution of the body into its elementary and inodorous gases in the cremation furnace, that intervening chemical link between the organic and inorganic worlds, the ammonia, is destroyed, and the economy of nature is thereby dangerously disturbed; thirdly, because the natural tendencies of the people lead them still to the earth, as the most fitting resting-place into which, when lifeless, they should be drawn.

Thus the cemetery holds its place in our city, but in a form much modified from the ordinary cemetery. The burial ground is artificially made of a fine carboniferous earth. Vegetation of rapid growth is cultivated over it. The dead are placed in the earth from the bier, either in basket work

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or simply in the shroud; and the monumental slab, instead of being set over or at the head or foot of a raised grave, is placed in a spacious covered hall or temple, and records simply the fact that the person commemorated was recommitted to earth in those grounds. In a few months, indeed, no monument would indicate the remains of any dead. In that rapidly-resolving soil the transformation of dust into dust is too perfect to leave a trace of residuum. The natural circle of transmutation is harmlessly completed, and the economy of nature conserved.

RESULTS.

Omitting, necessarily, many minor but yet important details, I close the description of the imaginary health city. I have yet to indicate what are the results that might be fairly predicted in respect to the disease and mortality presented under the conditions specified.

Two kinds of observation guide me in this essay: one derived from statistical and sanitary work; the other from experience, extended now over thirty years, of disease, its phenomena, its origins, its causes, its terminations.

I infer, then, that in our model city certain forms

of disease would find no possible home, or, at the worst, a home so transient as not to affect the mortality in any serious degree. The infantile diseases, infantile and remittent fevers, convulsions, diarrhœa, croup, marasmus, dysentery, would, I calculate, be almost unknown. Typhus and typhoid fevers and cholera could not, I believe, exist in the city except temporarily, and by pure accident; small-pox would be kept under entire control; puerperal fever and hospital fever would, probably, cease altogether; rheumatic fever, induced by residence in damp houses, and the heart disease subsequent upon it, would be removed. Death from privation and from purpura and scurvy would certainly cease. Delirium tremens, liver disease, alcoholic phthisis, alcoholic degeneration of kidney and all the varied forms of paralysis, insanity, and other affections due to alcohol, would be completely effaced. The parasitic diseases arising from the introduction into the body, through food, of the larvæ of the entozoa, would cease. That large class of deaths from pulmonary consumption, induced in less favoured cities by exposure to impure air and badly ventilated rooms, would, I believe, be reduced so as to bring down the mortality of this signally fatal malady one third at least.

Some diseases, pre-eminently those which arise

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from uncontrollable causes, from sudden fluctuations of temperature, electrical storms, and similar great variations of nature, would remain as active as ever; and pneumonia, bronchitis, congestion of the lungs, and summer cholera, would still hold their sway. Cancer, also, and allied constitutional diseases of strong hereditary character, would yet, as far as I can see, prevail. I fear, moreover, it must be admitted that two or three of the epidemic diseases, notably scarlet fever, measles, and whooping cough, would assert themselves, and, though limited in their diffusion by the sanitary provisions for arresting their progress, would claim a considerable number of victims.

With these last facts clearly in view, I must be careful not to claim for my model city more than it deserves; but calculating the mortality which would be saved, and comparing the result with the mortality which now prevails in the most favoured of our large English towns, I conclude that an average mortality of eight per thousand would be the maximum in the first generation living under this salutary *régime*. That in a succeeding generation Mr. Chadwick's estimate of a possible mortality of five per thousand would be realised, I have no reasonable doubt, since the almost unrecognised, though potent, influence of heredity in disease

would immediately lessen in intensity, and the healthier parents would bring forth the healthier offspring.

As my voice ceases to dwell on this theme of a yet unknown city of health, do not, I pray you, wake as from a mere dream. The details of the city exist. They have been worked out by those pioneers of sanitary science, so many of whom surround me to-day, and specially by him whose hopeful thought has suggested my design. I am, therefore, but as a draughtsman, who, knowing somewhat your desires and aspirations, have drawn a plan, which you in your wisdom can modify, improve, perfect. In this I know we are of one mind, that though the ideal we all of us hold be never reached during our lives, we shall continue to work successfully for its realisation. Utopia itself is but another word for time; and some day the masses, who now heed us not, or smile incredulously at our proceedings, will awake to our conceptions. Then our knowledge, like light rapidly conveyed from one torch to another, will bury us in its brightness.

By swift degrees the love of Nature works
And warms the bosom: till at last, sublimed
To rapture and enthusiastic heat,
We feel the present DEITY, and taste
The joy of GOD to see a happy world!

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EXTRA-TROPICAL PART. TROPICAL PART.

Temperate Extra-Tropical. Tropical ... Tropico-Temperate (partly Tropical and partly Extra-Tropical).

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SANITARY COMMISSION, No. 40.

A REPORT TO THE SECRETARY OF WAR

OF THE

OPERATIONS

OF THE

SANITARY COMMISSION,

AND UPON THE

SANITARY CONDITION OF THE VOLUNTEER ARMY,

ITS

Medical Staff, Hospitals, and Hospital Supplies.

DECEMBER, 1861.

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SUBJECTS.

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REPORT.

WASHINGTON, *December 9th*, 1861.

To the Honorable SIMON CAMERON,

Secretary of War:

SIR: By direction of the Sanitary Commission, I respectfully submit the following report of its operations since its appointment by you, on the 9th of June, 1861, pursuant to the recommendation of the Acting Surgeon General, under date of May 22, 1861:

ORGANIZATION AND DUTIES.

By your order appointing the Commission, it was vested with no legal authority, and with no power beyond that of "inquiry and "advice in respect of the sanitary interests of the United "States forces." It was directed, especially, to enquire into "the principles and practices connected with the inspection of "recruits and enlisted men; the sanitary condition of the vol- "unteers; to the means of preserving and restoring the health, "and of securing the general comfort and efficiency of troops; "to the proper provision of cooks, nurses, and hospitals; and to "other subjects of like nature."

The Commission has, from the first, fully recognized the fact that its office was purely auxiliary and advisory, and that it

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was created solely to give what voluntary aid it could to the Department and the Medical Bureau, in meeting the pressure of a great and unexpected demand on their resources.

The Medical Bureau especially, organized with reference to the wants of an army of only a few thousand men, seemed likely to be most seriously embarrassed in its operations, when called on to provide for a newly levied force of several hundred thousand, especially as both the officers and men of these hastily assembled regiments were mostly without experience, and required immediate and extraordinary instruction and supervision to save them from the consequences of exposure, malaria, unwholesome food, and other perils of camp life.

The Commission met for the first time at Washington, on the 12th June last, and proceeded to organize and to settle, so far as was then possible, the general scheme of its operations.

PRELIMINARY SURVEY.

For the purpose of a preliminary survey of the ground, the President of the Commission, Rev. Henry W. Bellows, D. D., immediately undertook an examination of the sanitary condition of the troops assembling at Cairo, St. Louis, and other military centres in the west, and a like preliminary examination was made by other commissioners into the state of the troops on the Potomac and at Fortress Monroe. Full reports of the results thus ascertained were submitted to the Commission, showing that the apprehensions entertained of dangers to the army from the neglect of the most obvious sanitary precautions, in regard to camp site, ventilation, drainage, &c., and from the general ignorance of officers and soldiers in regard to this subject, and in regard, also, to the forms of procedure to which medical and other officers are obliged to conform, in order to obtain supplies from the regular military sources, were in no degree exaggerated, and that there was a

vast field of work before the Commission, which Government could not, for the time being, fully occupy, but which could not be neglected without imminent risk of great public loss, and national calamity.

FINANCIAL BASIS.

As the Commission was to receive no pecuniary support from Government, it was under the necessity of calling on private liberality for the fund it required to sustain it. Its appeal for this purpose was responded to with promptitude and liberality, and the Commission was thus enabled to go into operation without delay. The Life Insurance Companies of Massachusetts, New York, and New Jersey, were most generous in their contributions—one of the number (the Mutual Life Insurance Company of New York) having given five thousand dollars to the objects of the Commission. It has received in money from all sources, up to the 25th of November last, twenty-eight thousand one hundred and seven dollars, ($28,107,) the larger portion of which has been contributed by citizens and institutions of New York. Whether public liberality can be depended on as a permanent source of supply is uncertain. Should it fail, the Commission will be under the necessity of terminating its labors, unless Government should see fit to assume its support.

ADVICE.

The Commission found itself charged with a two-fold duty, viz: of enquiry into the sanitary condition of the volunteer army, and of advice as to its improvement. This latter function included not only the duty of addressing to different departments of Government, from time to time, such recommendations or suggestions as occasion might suggest, but also that of keeping volunteer officers and soldiers themselves constantly and directly

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instructed and warned as to the novel dangers to which they were exposed, the necessary precautions against them, and the means pointed out by experience as best calculated to preserve them in bodily health and vigor for the performance of their duty to the country.

For this purpose the Commission proceeded, as speedily as possible, to secure the services of a body of physicians specially fitted for the required duty, and to send them into the field at various points from Fortress Monroe to St. Louis. In this it was retarded, not only by its limited means, but also by the difficulty of finding at once a sufficient number of gentlemen of the requisite qualifications. It was indispensable that they should possess not only scientific education and a special acquaintance with sanitary laws, but sufficient tact to enable them, though holding no official position or military rank, to perform their duties as agents of an organization unknown to the regulations of the army, without awaking jealousy of their inteference as officious and intrusive. It was also necessary, in view of the fact that the Commission could afford to pay but moderate compensation to its employees, that they should be men actuated by a strong and disinterested desire to be of service to the country.

Fourteen well qualified physicians are now employed by the Commission, each having a defined portion of the army under his observation. Six other gentlemen, each possessed of special acquirements, are engaged on special duties. A list of their names and of the posts to which they are respectively assigned is appended. It is proper to record the fact that they have in several cases withdrawn from positions far more remunerative than that now occupied by them, and have undertaken their present duty from motives of the highest benevolence and patriotism. Others have declined the office of Brigade Surgeon, tendered them by the War Department, to enter on what they considered a wider field of usefulness in the service of the Commis-

sion. No one is now employed on this duty who is not entitled, by education, experience, and social standing, to speak with a certain degree of moral authority; and whatever success the Commission may have attained in the execution of its duties, is believed to be due as much to the high character and intelligence of its Inspectors, as to all the other advantages it has enjoyed.

The duties of the Inspectors, beyond what has necessarily to be trusted to their discretion, are minutely detailed in the printed instructions issued to them, of which a copy is herewith submitted. It will be perceived that they are enjoined carefully to avoid whatever can excite apprehension of a disposition to interfere with military authority. Before entering any camp, they are required to obtain the formal approval of the Major General, the Brigadier General, and the Medical Director, in whose military jurisdiction it is included, together with an introduction to the commanding officer of the regiment, and through him to the company officers. Having done this, they are directed to make a minute investigation into every point bearing directly or indirectly on the sanitary condition of the camp.

Among the subjects to which their attention is especially directed, and on which they are required to make detailed written reports, are the quality of rations and of water, the method of camp cooking, the ventilation of tents and quarters, the drainage of the camp, the healthfulness of its site, the administration of the hospital and the sufficiency of its supplies, the police of the camp, the quality of the tents and of the clothing of the men, the material used for tent flooring, if any, &c., &c. Whatever deficiencies or evils they find to exist by which the health, morale, or efficiency of the men may be endangered, they are instructed to indicate to the proper officer, at the same time offering advice, if it is needed, as to the best method of remedying them. Very few camps have been visited in which important improvements have not been ordered, at the suggestion and in the presence of the Inspector.

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The influence, however, which officers unconsciously receive through the mere direction of their attention to neglected duties, by the inquiries which the Inspectors have need to address to them, constitutes the chief part of the value of the services of the Commission. This, of course, cannot be specified and recorded. But the effect of the advice given by the Inspectors of the Commission is found not to be confined to the particular camp visited, or to the officers with whom they converse. The example of one regiment in reforming abuses and enforcing sanitary laws is very generally followed by others near it, and an emulation is excited among company and regimental officers, the beneficial effects of which have been noticed in many cases where an ill-regulated regiment has been transferred to the neighborhood of a cleanly, well-policed, thoroughly drained, and salubrious camp. (See Appendix: *Example.*) Men who have been flooded out of their tents in a rain storm, get little sympathy from their neighbors who have been instructed how to protect themselves by drains, nor are those who feel a natural and soldierly pride in the good order and cleanliness of their camp generally careful to conceal it when they enter a camp inferior to their own. There is no doubt that systematic attention to sanitary laws is becoming more generally understood to be a part of the duty of a military officer; and it is satisfactory to observe that the more recently enlisted regiments begin better than those enlisted at the opening of the campaign, and improve faster. This, in part, may be fairly attributed to the publications of the Commission, which to the number of more than one hundred and fifty thousand have been scattered through the country and largely reprinted in the newspapers.

As every regiment brought to a high sanitary condition is found to be a radiating centre of good influences, it has been thought that the labors of the inspectors (their numbers being necessarily far too small) would be most effectively and economically

applied, by making as thorough work as practicable in the inspection of each regiment visited, and in securing the efficient co-operation of its officers, rather than in a superficial examination and hurried efforts for the direct benefit of a larger number.

The complete and accurate inspection of a single regiment, with the collection and recording of information on all the points to be embraced in the Inspector's return, cannot, as a rule, be performed in less than an entire day. If there are improvements to be suggested, and their necessity explained to officers fully engrossed with their new military duties, much additional time must be spent, and many more visits often paid, before the necessary orders are given, and carried into excution. But it should be added, in justice to our volunteer officers, that the Inspectors of the Commission have seldom had occasion to complain of any want of prompt, cordial, and intelligent co-operation on their part.

The Commission has distributed gratuitously to the surgeons and officers of the volunteers, three thousand each, on an average, of five concise treatises on the best means of preserving health in camps, and on the treatment of the sick and wounded in camp and the battle field. As the surgeons of the volunteer army are almost altogether drawn from civil practice, and as no books, or even circulars of instruction in regard to their novel responsibilities, have yet been supplied them by Government, these modest works have been found of considerable value.

INQUIRY.

After the inspection of each camp or post, the inspector is required to make an elaborate report upon its condition. This report consists mainly of written answers in the most exact and consise form to a series of printed questions, one hundred and

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eighty in number, covering every generally important point connected with the sanitary condition of the army.

More than four hundred of these reports have been received by the Commission. Their results are carefully tabulated, and suitable digests prepared by an accomplished actuary. The Commission is not without hope, if it should be enabled to continue its operations, eventually to lay before the country a body of military medical statistics more complete, searching, and trustworthy than any now in existence.

Information as to the condition of the army is obtained also from other sources. The Assistant Secretaries of the Commission, Doctor J. S. Newberry, Doctor J. Foster Jenkins, and Doctor J. H. Douglas, each having superintendence of a different geographical department, make, from time to time, reports in a more general form than those of the inspectors.

In certain cases, special agents are employed, and special investigations made. (See notes on Bull Run, in appendix.) Valuable reports have likewise been furnished by members of the medical staff; and members of the Commission have, themselves, undertaken investigations requiring special scientific knowledge.

CONDITION OF THE VOLUNTEER ARMY.

A brief statement of the condition, in certain respects, in which the army was found during the months of September and October, so far as this can be deduced from the reports of inspection made during those months, will best illustrate the character of the information obtained, and will serve to indicate the points to which it seems most desirable the attention of Government should be directed.

The number of regimental returns from which the statistics to be presented will have been derived is two hundred, and they will accurately indicate the condition of the army in the particulars specified, so far as the condition of the regiments in question,

taken at random, and some from each division of the army in the field, was at the time of inspection fairly representative of the condition of the whole. More general statements will be introduced where this is known not to be the case, or when, for other reasons, it appears to be necessary to fairly present the character of the information which has been collected by the Commission.

Of these returns, thirty-seven (37) were from regiments recruited in New England; one hundred and one (101) were from regiments recruited in the Middle States, including Virginia, Maryland, and Delaware; sixty-two (62) were from regiments recruited in the Western States, including Kentucky, Missouri, Kansas, and Nebraska.

Time of Recruiting.—The time occupied in recruiting each of these regiments averaged six (6) weeks, the shortest period being ten (10) days, the longest about three (3) months.

Nativity.—In seventy-six and a half ($76\frac{1}{2}$) per cent. of the regiments inspected, native Americans were found to constitute the majority.

In six and a half ($6\frac{1}{2}$) per cent. there was a majority of Germans; in five and a half ($5\frac{1}{2}$) of Irish; and in five and a half ($5\frac{1}{2}$) the number of native born and foreign born was about equal. Of one (1) per cent. the returns give no information on this point.

The relative proportion of foreigners and native born in the volunteer army cannot, at present, be stated with accuracy. It is certain, however, that it is not true, as has been stated, that the majority of the army is of foreign birth. It would probably be a near approximation to the truth to state that about two-thirds of our volunteer soldiers are American born, and nine

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tenths citizens, educated under the laws of the Union, and in the English tongue.

Age.—From incomplete returns, the average age of the volunteers is judged to be a little below twenty-five (25) years. Somewhat more than one-half of their number are under twenty-three (23.) The average age of the officers is about thirty-four (34.)

The number of men of any age between eighteen and forty is not far from double the number of those five years older. For example, the number of those twenty years old is double the number of those at twenty-five.

It is important that the degree of liability to death from disease in war, at different ages, should be ascertained. Data are accumulating which will serve to determine this. It is still more important to determine the degree of liability to sickness at different ages, in army life, especially as this affects the question of the relative efficiency of men, as soldiers, at different ages. For this purpose, no sufficient records are at present made by the surgeons of the army, and it is not practicable for the Commission to supply the deficiency. An improvement in the medical record of the army in this particular is therefore desirable.

Inspection of Recruits.—In fifty-eight (58) per cent. of the regiments, there had been no pretence of a thorough inspection of recruits on enlistment.

In only nine (9) per cent. had there been a thorough re-inspection when or after they were mustered in.

The Commission took occasion soon after its organization to address the Governors of all loyal States on the need of more vigorous inspection of recruits. It is unfortunately certain, how

ever, that this important duty has continued to be generally neglected or superficially performed.

A careful examination of the causes officially assigned for the discharge of 1,620 men from the army of the Potomac, as unfit for service, during the month of October, made by a committee of the Inspectors of the Commission, experienced in observation of military hospitals, leads to the startling conclusion that fully fifty-three per cent. of the whole number were thus discharged on account of disabilities that existed at and before their enlistment, and which any intelligent surgeon ought to have discovered on their inspection as recruits. This conclusion is sustained by information from other sources.

These men had each, probably, cost the Government at least one hundred dollars for his pay, rations, clothing, transportation, medicines, &c., making an aggregate of over eighty thousand dollars, absolutely wasted on men who ought never to have been enlisted. Extending the calculation just suggested to the whole army, and for the whole period since the commencement of the campaign, it seems probable that a million of dollars has been lost by mere neglect of preliminary inspection. This pecuniary loss, however, is small compared with that caused by the diminution of efficiency which every corps suffers by the introduction of any considerable number of men unfit for service, constituting, as they do, more than anything else, the "*impedimenta*" of the army.

It is difficult to say how far the process of eliminating from the army men who should not have been permitted to join it can now be carried with safety, but it is manifestly desirable that the most decided cases of disability be ascertained by a faithful re-inspection, and discharged from service, and that medical and military considerations be more rigorously enforced in future enlistments. The regulation prescribing the age of eighteen as a minimum should be invariably insisted upon. Every rule,

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indeed, as to medical inspection of recruits for the regular army, is equally applicable to recruits for the volunteer army, and should be enforced with equal strictness. Recruits properly rejected by the inspectors of the former have, in many cases, been allowed to enlist as volunteers, and have been invalided after a few weeks or months of service.

Another point connected with the volunteer recruiting service deserves more attention than it has received: the danger, namely, that follows the enlistment of men notoriously vicious and degraded. In the regular service, persons of this class are, from the very moment of enlistment, controlled in some degree by the habits of command that have been acquired by their officers, and by the systematic and exact discipline they are thus enabled to enforce. But, among newly-organized volunteers, this cannot be expected, until the whole command has been for some considerable time in service, and until the majority of the men have become soldiers in reality, as well as in name. While this educational process is going on, the mere presence in camp of half a dozen dissolute, insubordinate, and ruffianly men tends very much to retard the progress in discipline of the whole command. They set an example of unwholesome indulgence of every kind, thwart all measures for the sanitary improvement of the camp, are the first subjects of disease, and the first to turn their backs on the enemy. Whatever disloyalty and desertion have occurred among our soldiers, may generally be traced to persons of this class. It is to be hoped that all such will hereafter be rigorously excluded from the people's army.

It is also desirable that sanitary regulations at the various depôts for volunteer troops be strictly enforced; that every recruit be vaccinated immediately on enlistment; and that in-

creased attention be paid to the hygienic care of military companies in transitu by railroad and by transports.

Situation of Camps.—Camp sites have been generally selected for military reasons alone, and with little if any regard to sanitary considerations. The regimental surgeon has seldom been consulted on the subject. In many instances disease is directly traceable to this omission.

One fourth the regiments were found encamped on sites which had previously been occupied by others.

Except at Cairo and in the prairie region, camps have been generally formed on the tops and sides of hills. During the hot weather, nearly one-half were in the shade of woods—an objectionable circumstance.

Water.—Water of wholesome quality was found within convenient distance of the camp in all but two cases. The regiments encamped at Cairo were abundantly supplied with ice during the hot weather.

Occupation of Camp Sites.—The average occupation of a camp site, up to the date of inspection, had been twenty-one days. In the east this period has generally been largely exceeded, and regiments have frequently occupied the same ground much longer than is safe or advisable.

Drainage, natural.—Fortunately in those cases where the drainage by inclination was the most difficult, the soil and subsoil has been porous and favorable to drainage by filtration. As the immediate inconvenience occasioned by a shower of rain in these flat sides led to the practice of better judgment in artificial drainage than has generally obtained on the hill sites, there has been less prejudice to health from poor drainage in the fixed

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camps at the west than in those of the armies of the Potomac and Western Virginia, which have generally been upon clay soils or over retentive sub-soils. There has been, for instance, not half as much rheumatism at Cairo as in the eastern camps and those of Western Virginia.

Drainage, artificial.—Until recently, the artificial drainage of camps, when first visited by the Inspectors, has been found very imperfect—the men of each tent being left in most cases to form drains around it according to their own judgment. In consequence of their ignorance, unskilfulness, or indolence, the drains have often been useless, and not unfrequently have aggravated the evil they were designed to remedy. As soon, however, as good examples became frequent, the practice of a systematic arrangement began to be generally adopted. The majority of volunteer camps are now at least as well drained as those of the regulars. The average depth of the camp drains is about six inches. In about one-half the camps the drains were found more or less clogged, owing to their crookedness and imperfect construction, and to want of proper attention in keeping them clean.

The consequence of neglecting drainage are frequently apparent on inspection of the sick list, and more detailed regulations with regard to camp drainage are desirable. At present it seems to be nobody's business to lay out a system of drains. Without a complete system, drainage can seldom be effective.

Camp Arrangement.—In general, the plan for laying out a camp supplied in the *Army Regulations*, is approximately followed, but the tents are placed more closely together than the minimum there prescribed. The difficulty of drainage is thus increased, and the narrow spaces between the tents, difficult to be swept, become half-concealed receptacles for rubbish.

Tent Accommodation.—Six men are usually provided with lodging in one of the "wedge" tents. In the Sibley tent from twelve to sixteen; of late sometimes twenty.

Ventilation.—Tents are seldom tolerably ventilated at night. Of the regiments under consideration occupying the wedge tents, none were found in which the Inspectors were satisfied that proper attention was paid to ventilation, and it was obvious in some cases that the men suffered in health in consequence. The Sibley tent is more convenient of ventilation, and cannot as well be tightly closed as the wedge form. The Commission warned the Department, in August, of the evil likely to ensue from the difficulty of ventilating the wedge tents. It is now found that typhus is occurring more frequently in the regiments occupying these tents than in those that have the Sibley—the ratio being 29.5, to 23. The Massachusetts Seventh Volunteers, Colonel Davis, Surgeon Holman, is the only volunteer regiment reported, to the present date, in which a thorough ventilation of the wedge tent has been generally established. It was here induced by the occurrence of typhoid fever, and by this, prominently among other means employed for the same end, the most gratifying, and, at this season, unusual result of banishing this formidable disease has been obtained.

The Inspectors have advised the striking of each tent once a week, for the purpose of giving it a perfect cleansing and airing, and the practice is being of late quite generally adopted.

Tents.—Fifty eight (58) per cent. of the regiments had been provided with the wedge tent, ten (10) with the wall tent, seven (7) with the bell tent, nineteen with the Sibley, others not stated. Ninety per cent. of these were made of good canvass; the remainder were of twilled cotton or drilling, or so old as to be leaky.

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Flooring.—Twenty-four (24) per cent. of the regiments were provided with tent flooring of boards, twenty (20) per cent. with india-rubber cloth, in twenty-one (21) per cent. straw or branches were used for this purpose, and in thirty-five (35) per cent. the men slept on the ground.

The following table shows the relative proportion of these several kinds of flooring in the three great divisions of the army.

The important influence it will be doubtless found to exert on the health of the men justifies especial inquiry into the subject.

	Army of the Potomac.	Western Virginia.	Mississippi Valley.
Board flooring	25	20	23
India-rubber cloth	25	7	10
Straw or fir branches	19	23	23
None	31	50	44
	100	100	100

The following table shows the ratio of sick men per thousand in regiments which had been supplied respectively with india-rubber blankets; wooden tent-floors; straw, fir boughs, or cedar boughs; and in those which have been sleeping on the bare ground. The data are taken from the returns of 120 regiments, and chiefly in November.

REGIMENTS SLEEPING ON—	ENTIRE NUMBER OF REGIMENTS.	THOSE IN WESTERN VIRGINIA EXCLUDED
	Average ratio for 1000.	Average ratio for 1000.
Wood	75.7	61.5
India rubber	60.9	60.9
Bare ground	91.3	69.3
Straw or fir boughs	77.5	45.8

As the forces in Western Virginia were, as a rule, unprovided with rubber blankets, and as they have suffered special hardships in other respects, they are excluded from the comparison in the second column.

As rubber blankets had not, at the time the data were collected, been issued by Government, it is probable that the regiments furnished with them had also been better provided for than usual in other respects, and that those sleeping on the bare ground were generally at a greater distance from the supply depots than the others, and consequently not as well provided for in other respects.

A limited examination of the diseases of the army indicates that the largest proportion of those of typhoid type occur with regiments sleeping on rubber blankets, the least with those on straw or boughs; the largest proportion of catarrhal, with regiments on wooden floors, the least with those on the ground; the largest of rheumatism, with those on wood, the smallest with those on straw or boughs; the largest of malarial, with those on the ground, the least with those on straw or boughs.

As had been presumed by the Commission, it has been proved that the best bed for soldiers in camp, can, with a little skill, be formed from fir or cedar spray, whenever it can be obtained in sufficient quantity. The Inspectors have from the outset been instructed to advise its use whenever practicable. It should be frequently removed and burned, after a thorough cleansing of the tent floor, the tents being struck for the purpose.

Experienced officers generally object to the board floors in tents. They are thought to be more damp than the ground itself and they offer an opportunity for the collection of rubbish and dirt, and make them difficult of removal.

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Privies.—Privies had been established in all the camps inspected, except those of two or three regiments recently mustered in.

In eighty (80) per cent. of the camps, they are reported to be properly arranged and kept in proper order, no offensive odor drifting from them. In twenty (20) per cent., proper attention was not given to them, and the health of the men was more or less seriously endangered in consequence.

In sixty-eight (68) per cent. of the camps, the men seemed to be effectively restricted to the use of privies. In thirty-two (32) per cent., the proper prohibition was found by the inspectors not to be strictly enforced.

In thirty-five (35) per cent., the men were allowed, at least at night, to urinate within the camp limits. Night buckets, which are regularly provided, one for each tent, in the British service, are nowhere in use. The Commission does not think it desirable that they should be added to the camp furniture, believing that their cleaning would be too frequently neglected.

Disposition of Offal.—In seventy-seven (77) per cent. of the volunteer camps, slops, refuse, and offal are systematically removed to a distance from camp by a daily detail of men.

In twenty-three (23) per cent., this duty was performed irregularly, or very imperfectly. In nineteen of these twenty-three camps, the inspectors found odors of decay and putrefaction perceptible in and about the tents and streets.

Stables.—Stables are sometimes found actually within the camps, and quite frequently within half the distance prescribed by the *Regulations.*

In rather more than fifty (50) per cent. of the camps, the manure and litter of the horses are allowed to accumulate for an

indefinite period. In the rest, this source of danger is removed to a distance, or burnt, once a week, or oftener.

Camp Police, in general.—Of the camps inspected, five (5) per cent. were in admirable order, forty-five per cent. fairly clean, and well policed. The condition of twenty-six (26) per cent. was negligent and slovenly, and that of twenty-four (24) per cent. decidedly bad, filthy, and dangerous.

In those camps which are referred to as in a neglected and positively bad condition, some or all of the following sources of danger to the health of the men were found to exist, viz: drains wanting or clogged up, and retentive of stagnant water; the camp streets and spaces between the tents littered with refuse food and other rubbish, sometimes in an offensive state of decomposition; slops deposited in pits within the camp limits, or thrown out broadcast; heaps of manure and offal close to the camp, and the privies neglected.

In about two-thirds of the camps, the streets were found fairly clean, but in only about one-third were the edges of tents, the spaces between them, and the camp drains, entirely free from litter and rubbish.

On the whole, a very marked and gratifying improvement in the custom of the volunteer regiments in respect of camp police has occurred during the summer. Faults in this respect, which were at one time generally regarded as unworthy of the attention of regimental officers, are now considered disgraceful, and the number of camps in which officers and men take pride in maintaining an exact and severe camp police, is rapidly increasing.

Clothing.—The shirts used by the men were found to be of poor quality in twenty-six (26) per cent. of the regiments examined. In seventy-four (74) per cent., they were of the Reg-

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ulation quality. In ninety-four (94) per cent., the men had been provided with two shirts each. In four and a-half ($4\frac{1}{2}$) per cent., they had but one each, and in the remainder only a part were properly supplied.

A want in this and other articles of clothing frequently arises from the fact that the men have sold or bartered away a part of what they have received.

In nothing are the volunteer officers more remiss of their duty than in that of ascertaining such deficiencies, and in making them good upon a charge against the pay of those who are responsible for them. A proper overstock of clothing is seldom kept in regiments for this purpose. Officers have often been known to degrade themselves, their Government, and their commands, by begging for supplies of clothing, as a charity, which their men were abundantly able to pay for, and which it was their duty to obtain for them, and make them pay for.

Eighty-two (82) per cent of the regiments were well supplied with overcoats, and seven (7) per cent. partly so. In eleven (11) per cent. there were none at the time of the inspection. In only three (3) per cent. of the regiments were the overcoats of poor quality. Seventy-five (75) per cent. of the regiments were provided with good cloth body coats; the remainder with flannel sack coats or cloth jackets.

Of two hundred regiments, all were provided with pantaloons—one hundred and seventy-five sufficiently, eight indifferently, seventeen very poorly.

Men have been frequently seen during the summer on duty and on parade in their drawers alone.

In seventy-five (75) per cent. of the regiments, one good blanket had been issued to each soldier. In twenty (20) per

cent., two had been provided; these being, however, in most cases, of inferior quality. In five (5) per cent. the men had never all received each a blanket.

Deficiencies in the regulation allowance of clothing, noted in October, have since been generally made good. Where they have not, it is in nearly every case owing to the ignorance, negligence, or knavery of regimental and company officers. There are ample supplies of all necessary articles of clothing, including gloves and socks, in the principal depôts, from which all wants still existing can be supplied at short notice upon the requisitions of the proper officers.

Never, probably, was so large an army as well supplied at a similar period of a great war.

Cleanliness.—In about eighty (80) per cent. of the regiments, the officers claimed that they gave systematic attention to the personal cleanliness of the men; but in very few instances—almost none—is this attention what it should be. The washing of the feet is very rarely enforced as a military duty, and in not more than six per cent. of the regiments did the inspectors believe, from personal observation, that the officers strictly enforced the *Army Regulations* in respect of washing the head and neck. In eighty per cent. of the regiments, the officers reported that the men washed their shirts at least weekly. In the remainder the want of a change was sometimes given as a reason for this neglect. In 90 per cent. the officers professed to comply with the *Army Regulations* in regard to the removal of dirt from their woolen clothing; but, from observation, it is obvious that this is very rarely done in a thorough manner.

The volunteer army is more unsoldierlike in respect to matters of this kind, and its improvement has been slower in them than in any other. That scrupulous nicety and exactness in the care

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of articles of dress and equipment, which gives so much occupation to regular soldiers, and which is not only important to be observed for the sake of their health, but as presenting the surest evidence of a high condition of discipline and efficiency in all other respects, is, as yet, entirely unknown. A proper military inspection scarcely ever occurs in a volunteer regiment. Recently, the inspectors of the Commission have been required to return answers to the question: "*Are officers and soldiers on duty allowed to wear* "*their coats partially buttoned, or to follow personal inclination in* "*matters proper to be made uniform and regular?*" In nearly seventy-five (75) per cent., officers, when advised with on this point, confessed that very little attention was paid to such matters, and in most instances could not understand the object of the inquiry, thus showing that they had not a proper appreciation of the value of uniformity, of their own duties, or of the trouble that would be saved them in their duties by a strict enforcement of the intention of the *Regulations* in this respect.

A chief advantage of the uniform of military bodies is, the facility it affords for keeping their equipments in serviceable order. When every man is expected to appear, in all matters of dress, the exact counterpart of every other man, the attention of the officer is arrested by a very slight neglect of proper care of his equipment on the part of any individual. On the principle of the proverb, "A stitch in time saves nine," it is easier and cheaper, for both officer and private, that no day passes without every stitch of clothing, every strap, buckle, and button being put in the best possible condition. In European armies, every man is required to be provided with, and constantly carry about him, not only articles necessary for the repair of his clothing, belts, &c., but conveniences for cleaning both his person and clothing; as, for instance, a switch or cat for whipping dust to the surface of cloth, and a brush to remove it; oil, emery, whiting, blacking and brushes, for straps, shoes, and buttons.

In the British army, every private is furnished with a tooth brush, which he is required to show in his knapsack at the Sunday morning inspection. The economy of this regulation may be inferred from the prevalence of toothache and swollen faces in our camps.

Among volunteers it is somewhat rarely that men are found provided with the few articles which are essential to an economical care of their clothing; still more unfrequently are they found possessed of those which are requisite to the maintenance of health in crowded camps and quarters. This want also stands directly in the way of the development of that esprit du corps, which is as essential to military efficiency as to health, and is the only reason which can be assigned for the greater difficulty which the inspectors have found in inducing a marked improvement in this direction, than in any other.

It seems desirable, therefore, that such articles should be made a part of the Government supplies, and that every man should be required to show that he has them properly stowed in his knapsack, at each Sunday morning inspection—new issues from the quartermaster being made to supply losses in the same manner as of clothing, the value of all beyond the yearly allowance being deducted from the monthly pay of those making this necessary.

Slovenliness is our most characteristic national vice. Frontier necessities and costly labor account in a measure for this. The indirect influence exerted upon all parts of the country by a peculiar local system of labor explains more. The city of Washington illustrates the vice and the penalty that is paid for it. Structures designed in themselves to be commensurate with and typical of the moral grandeur of a great republic, are offences against good taste, like precious stones on dirty hands, when seen from out of the unmitigated shabbiness and filth of the unsewered, unpaved, unpoliced streets of a collocation of the

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houses of citizens who cannot remedy the evil. "The National Hotel sickness" was a beneficent reproof of the narrow policy which demands it of them. That which was lost by it, could have been cheaply saved, at an expense ten times as great as would be the necessary cost of making Washington a healthful, beautiful, and appropriate rural metropolis; an attraction, an example, and an unceasing influence for good, in this way, to the whole nation. Yet we compel our most valued public servants to reside in this capital, and with abundant evidence that similar causes are liable to induce, any day, a far more deadly and sweeping pestilence, do nothing to remove them.

While the simplest, though most absolute, sanitary laws are thus disregarded in high places, it need not be thought strange that the Inspectors find it peculiarly difficult, even after typhus has entered the camps, to make the volunteer officers realize the actual military necessity upon which the army regulations, with reference to the personal cleanliness of the men, are based.

If five hundred thousand of our young men could be made to acquire something of the characteristic habits of soldiers in respect to the care of their habitations, their persons, and their clothing, by the training of this war, the good which they would afterwards do as unconscious missionaries of a healthful reform throughout the country, would be by no means valueless to the nation.

But whatever measures can be taken which will tend materially to improve the habits of the volunteers in this respect, will undoubtedly be amply repaid in their greater health and better spirit in their duty.

The recommendation made to the Department, in August, that each soldier should be provided with a clothes brush, shoe brush, tooth brush, comb, and towel, adapted to be carried snugly in

the knapsack, and for which he should be required to account weekly, is therefore respectfully renewed.

Food.—The regulation articles of food are universally acknowledged to be had in great abundance, and their quality is, in nearly all respects, generally satisfactory to the men.

The chief complaint is want of fresh vegetables, and this is mainly confined to regiments in which, through the neglect of the officers, company funds are wanting.

Dessicated vegetables are used to some extent, but are not popular, because the men have not learned how to cook them. Regulars have been found to prefer them to fresh vegetables.

At the commencement of the campaign, captains of companies generally neglected to make requisitions for rations in proper form, and it was often said that they could never be made to do so. As such requisitions are the only honest foundation of the army system of supply, the Inspectors were directed to give particular instructions on this subject, and to urge strenuously their adoption. The result has been satisfactory. Requisitions are now almost universally made in proper form, the exceptions being in the case of new regiments, and in these only for a short time after they are mustered into service.

Company Funds.—The Commission, soon after its organization, recommended to the proper department of Government, as an important sanitary measure, the issuing of an order by which the commutation of rations, or sale to Government of surplus food, otherwise wasted, would be facilitated, and volunteers thus encouraged to vary their diet by the substitution of articles not supplied in the ration. Such an order was at length issued, and, though the volunteers are very slow to comprehend it, or believe

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in the advantages which it offers, a very satisfactory advance in this respect is recently reported.

In forty per cent. of the regiments inspected during the month of November a company fund existed in every company; they had been formed also in several companies of many other regiments. In one hundred and thirty-six out of two hundred inspected prior to November 1st, not a single company fund had been commenced.

The company fund is the soldier's only resource for many articles indispensable to his health, comfort, and efficiency, *e. g.*, fresh vegetables, butter, milk, pepper, (no condiment but salt being supplied by Government;) many utensils required for cooking and saving rations; knives, forks, spoons, brushes, blacking, &c. Cavalry and artillery men depend on it for many other articles required for their efficiency and creditable appearance. Its formation, therefore, promotes the health of a regiment not only directly, but also by improving the morale, soldierly feeling, and self respect of the men, which have no small influence on their physical condition.

It may be added that the existence of a company fund operates as a check on frauds on the Commissary and Quartermaster's Departments, and tends to diminish the danger of disease to which sutler's shops expose the men.

In one case fifty-seven (57) dollars have been saved in a month, the men, according to their own testimony, having fared well. The saving ought to amount to at least six thousand dollars per annum for a regiment of one thousand men, and this amount is wasted whenever company funds do not exist.*

The Inspectors of the Commission have all done much to re-

* Company savings of one hundred dollars a month have been more recently reported.

move objections, and induce the attempt to form the fund in every company they have visited; and in the army of the Potomac, one of them has for sometime been almost exclusively employed in demonstrating its practicability and advantages.

Hospital Fund.—Analogous to the company fund, and of like importance, is the hospital fund, raised in similar manner, by the re-sale to Government of the rations not needed by men while in hospital; or, in other words, by the commutation of these rations for their money value. On this fund the volunteers have to rely for hospital bedding and clothing, and for all the extra delicacies, and medical and other appliances which the sick and convalescent require. Yet it exists in the regimental hospitals of not more than one-third of the volunteer regiments now in the field.

Cooking.—The volunteers do not, as a general rule, take kindly to cooking, but of late no serious complaint on this score has been reported. The system of rotation of cooks that prevails in the regular army is not generally adopted, and the manner of selecting cooks is very varied.

Army cooking is generally done by fires made in trenches, in the most simple and primitive manner. Not more than ten per cent. of the regiments inspected use cooking stoves of any pattern. Several which employed them for a time have given them up and adopted trenches and an open fire, as practically more efficient and convenient under the circumstances.

The cooking of the volunteers constantly improves, and, however rude, is probably already more wholesome than that which the average of the men have been subject to before enlistment, because some of the most deleterious modes of cooking to which

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they have been accustomed are not practicable in camps. It must be added, however, that peddlers of "pies" and other ill-prepared and injurious articles are generally admitted into camp with little, if any, restriction, and are subject to no efficient supervision. Fluctuations on the sick list have been, in certain cases, found to be directly corresponding with the greater or less facility of access to the men given the pie-peddlers.

A regular and thorough inspection of the contents of all peddlers' wagons coming to the camp has been instituted by order of the Colonel, at the suggestion of an inspector of the Commission, in several regiments, with manifest advantage. If an inspection of markets is a necessary civic office, an inspection of peddlers is certainly a necessary office for our camps. There would seem to be occasion for a general order or regulation on this subject.

Sutlers.—In this connexion reference cannot be avoided to the evil which often comes to the men from the sutler's shop. There would be little objection to the present sutler system were the instructions of the *Army Regulations* thoroughly carried out. But it is unquestionably true that proper control and supervision of the sutler is scarcely ever maintained in volunteer regiments.

There is reason to believe that corrupt bargains have been formed in certain instances between the sutler and officers of his regiment; that in other cases officers receive presents of wine from the sutler; that sutlers have used their influence and power over the men to prevent them saving from their pay for the sake of their families, and that they sometimes engage in the secret sale of spirits.

Of two hundred regiments inspected in September and Octo-

ber, twelve (12) were without sutlers. Of the one hundred and eighty-eight (188) sutlers, one hundred and three (103) were appointed by the colonel of the regiments, sixty-three (63) by the Secretary of War, fourteen (14) by a board of regimental officers, five (5) by Governors of States, and the appointment of three (3) was not ascertained.

In one hundred and four (104) regiments a tariff of prices for the sutler's shop was said to have been established, although it was very rarely "conspicuously posted," as required by the *Regulations.* It had been fixed in some instances by a regimental board or council, and in others by the sutler himself. In eighty (80) regiments, the price of articles sold was not fixed, and in four (4) the fact was not reported.*

Drunkenness.—In thirty-one (31) regiments, the sutler was allowed to sell liquor. In one hundred and sixty-nine (169), the officers reported that the sale was prohibited. In one hundred and seventy-seven (177), it appeared that the men did, in fact, get liquor with more or less freedom and facility from the sutlers

* The following is an extract from the communication of a surgeon of a volunteer regiment, addressed to the Commission:

"In our regiment we have the best sutlers on the Potomac; *nevertheless they prove, in actual practice, an unmitigated curse.* Some of the men throw their rations away, and literally live on sutler's *trash.* Others will eat a full ration, and then go straight to the sutlers and eat three or four villainous pies. Many of these have been fried in condemned lard a week before the soldier eats them. The result is camp *diarrhœa*, *dysentery*, and all their concomitant evils.

"Sutlers are a twofold evil. By them the soldier is tempted to spend his earnings, which should be saved for a purpose, and is made sick in the same transaction. My observation and experience in camp prove clearly that to keep a soldier *healthy* you must confine him to plain and regular rations.

"If Congress would pass a *law*, the tendency of which would be to *compel* the soldiers to live on the Government rations only, it would prove a blessing of infinite value to the service."

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or otherwise. In twenty-three (23), the inspectors were satisfied that the men did not often or readily obtain liquor.

It must not be understood, however, that in all the regiments which had access to liquor there was any serious habitual excess in its use. Intoxication was acknowledged to be common in only six (6) regiments. In thirty-one (31), it was said to occasionally occur, though not deemed a serious evil; and in one hundred and sixty-three (163), the inspectors were assured, and had no reason to doubt, that it was very rare. In the majority of regiments there is very little dram-drinking, except shortly after pay-day. The volunteers are believed to be more temperate than any European army. Most of the liquor drunk by the volunteers is probably obtained from the pie peddlers. When other means fail, it is conveyed in the pies.

In certain regiments containing a large per centage of Germans, lager beer has been freely used. There is evidence before the Commission tending to show that its use (at least during the summer) was beneficial, and that disorders of the bowels were less frequent in companies regularly supplied with it in moderation than in other companies of the same regiment.

Discipline.—The daily average of men in the guardhouse was reported to have been—

In 4	regiments	-	-	7
8	do.	-	-	6
17	do.	-	-	5
15	do.	-	-	4
39	do.	-	-	3
41	do.	-	-	2
57	do.	-	-	1
4	do.	less than one.		
15	do.	not stated.		

The average is $2\frac{6}{10}$ men to each regiment.

Men are generally kept effectually within camp limits. The average daily absences from camp were eight for each regiment.

The Inspectors of the Commission have been instructed to give attention to certain matters solely as tests of discipline.

The reason for this is explained in the following Resolutions, adopted by the Commission in July:

"*Resolved*, That the Sanitary Commission, in their endeavors to promote temperance, cleanliness, and comfort among the troops, have become convinced that the first sanitary law in camp and among soldiers is *military* discipline; and that unless this is vigorously asserted and enforced, it is useless to attempt and impossible to effect, by any secondary means, the great end they propose—which is the health and happiness of the army.

"*Resolved*, That looking only to the health and comfort of the troops, it is our profound conviction that any special relaxation of military discipline in favor of volunteer troops, based either upon their supposed unwillingness or inability to endure it, or upon the alleged expectation of the public, is a fallacious policy, and fraught with peril to the lives of the men and the success of the national cause; and that, speaking in the name of the families and the communities from which the volunteers come, and in the name of humanity and religion, we implore that the most thorough system of military discipline be carried out with the officers and men of the volunteer force, as the first and essential condition of their health, comfort, and morality.

"*Resolved*, That the health and comfort, and efficiency of the men, is mainly dependent on the uninterrupted presence, the personal watchfulness, and the rigid authority of the regimental and company officers; and that all the great defects, whether in the commissariat or in the police of camps, are radically due to the absence of officers from their posts, and to the laxity of the discipline to which they are themselves accustomed—a laxity which would never be tolerated among regulars, and which, while tolerated among our soldiers, will make our force a crowd of armed men rather than an army.

"*Resolved*, That it is the public conviction of this Commission, that the soldiers themselves, *in their painful experience of the want of leaders and protectors*, would heartily welcome a rigid discipline exerted over their officers and themselves; that the public would hail with joy the inauguration of a decisive, prompt, and rigid rule, extending alike to officers and men; and that any despondency or doubt connected with our military and

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national prospects, or with the health and security of our troops, would disappear with the first indications of rigid order enforced with impartial authority throughout the whole army."

The opinion is often expressed by professional soldiers that an effectively disciplined army can never be made of volunteers, and that as undisciplined men can only be used in war in limited numbers, chiefly to preserve the fighting force from excessive fatigue, it is a waste of the public resources to keep a large volunteer force in the field. Many volunteers express, in effect, their acquiescence in this view, when they say, "You cannot expect volunteers to be as particular as regulars"—an answer constantly given to the suggestions of the Inspectors, when they find a regiment the condition of which is in all respects disgraceful to its officers. To the consideration that this war is to be waged against volunteers, the reply of those who believe that only a large army of regulars can prosecute it to a successful end, is, that undisciplined forces are much better adapted for defensive than for offensive operations, and that volunteers can never be pushed to the heart of the rebellion, however they may hack at its extremities. This view is habitually sustained by those whose position entitles their judgment to be regarded with respect, and the question whether volunteers can be effectively disciplined thus becomes a serious one for the nation, and may be thought to give an importance to the information obtained by the Commission, aside from its sanitary bearing.

Discipline is a habit of prompt and exact obedience under certain authority. Being a habit, it cannot be taken on, except by a more or less rapid process of acquirement. So long as progress is being made, a satisfactory state of discipline is not only to be thought yet possible of attainment, but it may be probable.

There have been a few regiments of volunteers in which no progress in discipline during a considerable period could be ob-

served. Special causes were obvious in every such case, and they were notoriously exceptional in character. There is no room for doubt that in a large majority of the volunteer regiments there has been from month to month a perceptible advance in discipline.

This is true not only of those regiments which have been commanded by officers educated at West Point, but of those the commanders of which six months ago had never had a sword or musket in their hands, never read a military book, never saw a company of soldiers. It is true not only of regiments of volunteers the officers of which were selected by the War Department or by Governors, but of those which elected their officers. It cannot even be said that a very marked difference in the progress of these different classes is to be observed. The advantage of educated and appointed officers over elected civilians is clearly manifest only in the fact that the former have in no case—as far as known to the Commission—allowed their regiments to fall into the rare, exceptional, excessively demoralized condition before referred to. Regiments of volunteers having an unusual strength of West Point officers have in all cases been found in a fair state of discipline, so that if an order with reference to matters of camp-police was given at the suggestion of an Inspector of the Commission, it could be assumed that it would not be neglected. But this has been equally true of many regiments whose officers were taken from civil life and elected.

It cannot of course be concluded that military education and experience is of no value, nor that there are no disadvantages attending the election of officers. But it may be fairly concluded that a special military education is not at all necessary to adequate appreciation of the value of discipline or to the enforcement of discipline. There is, indeed, room for doubt if the conviction which prevails with regular officers of the difficulty of enforcing discipline with volunteers, and their consequent hesitation and

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endeavors to accommodate their habits to the supposed necessity for moderation in the exercise of authority in dealing with volunteers, is not a greater hindrance to their progress in discipline than the inexperience of the officers chosen from among civilians.

The disadvantage of the latter is certainly less, and the progress of their commands in discipline greater, compared with that of regulars and with volunteers commanded by regulars, than the Commission, influenced by the judgment of experienced military advisers, had been led to expect. In not a few cases where the officers of a regiment appeared at the outset peculiarly incompetent, quite careless of discipline and incapable of establishing it, after a few months a very decided improvement has been observed.

To account for this, it is only necessary to reflect that the habit of command grows, as well as the habit of obedience, and that if an officer does not habitually perform his proper duties, and see that the orders which, in the performance of his duties, it is necessary he should give, are carried out, discomfort is sure to result both to himself and to his command. Such officers, however popular they may have been when elected, soon become aware that the accidents, privations, and discomforts to which their men, through their neglect, are subject, are bringing ridicule, contempt, and hatred upon themselves, and they are thus driven to resign, or they fall into practices which cannot be overlooked by higher authority, and which lead to their dismissal, or they yield more and more to the habit of military authority, and will gradually learn that the simplest and easiest, and most popular course, is that of the most complete discipline.

Thus, throughout the volunteer army, the Commission has of late been gratified to find the habit slowly forming and strengthening, the general absence of which in July seemed to involve the greatest danger to health.

Commiseration for what are erroneously considered technical

offenders, and moderation or neglect in dealing with them, is costing the country more lives by far than the bullets of the enemy, and is adding many millions to the expense of the war. A strict enforcement of the *Army Regulations* would do more to prevent disease than all that the Commission can recommend to be done by other means. Neglect in their enforcement will be due less, hereafter, the Commission is convinced, to the ignorance and inefficiency of regimental and company officers, than to the inadequacy of the general staffs for their proper inspection, instruction, and superintendence. And it may here be proper to observe, that causes of disease and death can often be traced with great confidence to the occupation of military officers of high rank in merely clerical duties, and to delays and neglects which arise from the want of sufficient aids and clerks in administrative offices and headquarters. There is no office of Government, civil or military, with which the Commission has had frequent communication, which is not charged with such a weight of duties that it is impossible they can be got through with, except at an expense of labor to certain individuals, which cannot be long sustained without crippling the faculties which the good of the country needs to have constantly exercised in them.

Recreations.—About one-fifth ($\frac{1}{5}$) of the regiments possessed libraries, mostly of religious books. They were generally donations made to the chaplain.*

* There is a large religious element in the volunteer force. Religious organizations already exist in about half the regiments, and are rapidly increasing in number. The American Tract Society of Boston alone has distributed among them more than 20,000,000 pages, (equal to 60,000 12mo. volumes.) The number of letters written by the volunteers is remarkable, and a delightful indication of a fact which should remove all fear of a permanent military despotism in this country. In some regiments, of 1,000 men, it has averaged, for weeks, above six hundred a day. For all the regiments it must have been, through the summer, not far from three hundred. In some regiments, as Wilson's 22d Massachusetts, there is not a man unable to thus communicate with his friends at home.

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There is an intense demand for books and periodicals, generally of the lighter class, and for newspapers. Reading matter of almost every class is gratefully received. The Inspectors are able to supply this demand in some small degree from the stores consigned to the Commission, but hospital patients are considered to have the first claim upon them. In one case, sixty dollars had been subscribed by a company from its ration savings for newspapers, a tent having been also got, which was used as a reading room.

In forty-two (42) regiments, systematic athletic recreations foot ball, base ball, &c.) were general. In one hundred and fifty-six (156) there were none. As to two (2) the fact is not reported. Where there are none, card-playing and other in-door games generally take their place. There is some evidence of serious mischief from gambling. Sharpers are believed to have enlisted for the purpose of making money as professional gamblers. One (a non-commissioned officer) is reported to have boasted of large gains. But however this may be, the practice prevents the men from maintaining both mind and body in health by active amusement in the open air.*

Officers have not yet learned that it is a part of their duty to influence their men to this end. The observation was made by Baron Larrey: "After the accustomed military exercises, it is "desirable that the men be subjected to regular hours, gymnas-"tic amusements, and some mode of useful instruction. It is in "this manner especially that mutual instruction established "among the troops of the line is beneficial to the soldier and the "state. Warlike music during their repasts or at their hours

* In the Second New York Artillery, Major H. P. Roach commanding, the men are receiving a regular and thorough gymnastic training. In many respects this regiment is in a more satisfactory sanitary condition than any other inspected to the date of this report.

"of recreation will contribute much to elevate the spirits of the "soldier."—*Surgical Essays, p.* 178.

Regimental Bands.—Of two hundred (200) regiments, one hundred and forty-three (143) were provided with bands, fifty-three (53) had none, and as to four, (4,) the fact is not reported. These bands are not generally of the first order, by any means, but are sufficiently good to please and interest the great majority of the soldiers. The men are almost universally proud of their band, particularly so if it be of more than average respectability, and like to compare it with others which they think inferior. It is, in many instances, supported in considerable part by a self-imposed tax on the pay of both officers and men, which sometimes is as high as five per cent. The Inspectors of the Commission report that this contribution is cheerfully paid.

They also frequently report that they have been much struck by the value attached by the men to military music on a scale larger than that of the bugle, fife, and drum; and that they are satisfied of the wholesome and stimulating influence of even a third-rate band; that it raises the spirits of the men, warms their patriotism and their professional feeling as soldiers, and thus actually tends (not so remotely as might at first appear) to promote health, discipline, and efficiency. This is particularly important in view of the small extent to which healthful recreations have been introduced into camp.

Dr. J. H. Douglas, who was despatched to Poolesville as special Inspector immediately after the battle of Ball's Bluff, reported to the Commission on this subject as follows:

"I am convinced that music in a camp after a battle, whether "it is a successful or unsuccessful engagement, is of great im-"portance, but especially so after a defeat. One of the soldiers "said to me, 'I can fight with ten times more spirit, hearing the "band play some of our national airs, than I can without the

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"music.' Others of the wounded said they wished the bands "would play more frequently."

Similar remarks have been often reported.

It is hoped that every encouragement may be given to the formation and improvement of regimental bands, so far at least as a proper economy will permit.

Remittances of Pay.—The soldiers of fifty-seven (57) per cent. of the regiments had sent home to their families a considerable portion of their pay. Of the remainder, many had not been paid at the date of inspection.

The men are generally disposed to send home from half to three-fourths of their pay, if satisfied that they can do so safely.

It is respectfully submitted that the remittance of pay by the soldiers to those dependent on them should be encouraged and facilitated in every possible way.

The practice improves the moral tone of the soldier, by keeping up his sense of a continuing relation with his family. It tends to preserve him from the vices of the camps, and from becoming a mere mercenary man-at-arms, and it thus makes him a better citizen when he returns to civil life. Being most abundantly fed and clothed by Government, he scarcely needs money, except occasionally to replace some lost or worn-out articles of clothing. He can, in fact, in most cases, scarcely spend it otherwise, without positive injury to himself. What is not sent home, is nearly certain to be laid out in unwholesome food (pies and the like) or more unwholesome drink, to the damage of his health and the diminution of his efficiency, to the cost of Government. As a general rule, the regimental pay day is immediately followed by an enlarged sick list, and a more populous guard-house.

It is confidently believed, that if fifty per cent. of that portion of the soldiers' pay which he spends in camp were thrown into

the Potomac, he would, on the whole, be the gainer, the only loser being the sutler and the peddler.

Moreover, the neglect to remit the soldier's pay often leaves his family dependent on public or private charity. There is danger of a great pauper class being thus created, especially in our large cities; and the existence of this class, always most undesirable, will be peculiarly mischievous at the present critical period by increasing local taxation and general distress, weakening the national resources, and wearying the people of the present just and necessary war.

The disposition among our soldiers to remit the largest part of their pay should, therefore, be gladly encouraged and aided in every way by Government, nor should there be any hesitation in incurring any reasonable expenditure which will confirm and strengthen so gratifying a characteristic.

Qualifications of Surgeons.—The qualifications of Regimental Surgeons, in respect of education and experience, cannot, as a general rule, be ascertained by direct inquiry. The Inspectors, however, are usually able to form a decided opinion on this point, by conversation, and by observing the mode in which the surgeon's duties are performed.

They report the Surgeons of one hundred and seventy-six (176) out of two hundred (200) regiments in question, sufficiently well qualified; four (4) incompetent; thirteen (13) of doubtful competence; and as to seven (7) regiments, the point is not reported upon, owing to the absence of the surgeon from his post, or to some other reason.

One hundred and twenty-nine (129) of these Regimental Surgeons are reported as not only competent, but as having discharged their duties with creditable energy and earnestness; twenty-five (25) to have done so with tolerable attentiveness; nineteen (19) to have been negligent and inert; of the surgeons of twenty-seven (27) regiments, no distinct opinion is expressed.

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Camp Hospitals.—The arrangement, equipment, and supplies of the Regimental Hospitals are reported to have been in one hundred and five (105) of the regiments, good; fifty-two (52) indifferent or tolerable; twenty-six (26) bad.

In thirteen (13) regiments, no hospital whatever had been organized. As to four, there is no report.

The following table shows the aggregate strength of the two hundred regiments under consideration; the numbers sick in hospitals and in quarters; the proportion sick in hospitals and quarters to every 1000 strength, and to every 1000 cases on the sick list:

Of 200 regiments last visited previous to November, 1861.	Aggregate numbers.	PRESENT STRENGTH ON SICK LIST.	
		Proportion to every 1,000.	Proportion to every 1,000.
Strength when mustered	176,639		
Strength when inspected	176,042		
On sick-list at the time of inspection	12,841	73	1,000
Sick in General Hospital	2,756	16	215
" Regimental Hospital	2,973	17	231
" Quarters	7,112	40	554

Resumé.—The table on the following page presents a resumé of the statements which have been given as to the condition of two hundred regiments. The returns of all inspections are reduced to a similar, exact, and concise form, and the precise condition of each regiment, of each brigade, of each division, of each department, and of the volunteers from each State, in all the particulars indicated, is separately tabulated at the office of the Commission. The causes of special disease may thus, sometimes, be demonstrated in a moment.

Table showing the Character of the 200 Regiments last inspected by the United States Sanitary Commission previous to 1st November, 1861.

No. of query in printed forms of Inspection Returns.	SUBJECTS OF INQUIRY.	Extremely bad. 1	Very bad. 2	Bad. 3	Moderately bad 4	Indifferent. 5	Moderately good. 6	Good. 7	Very good. 8	Extremely good. 9	Perfect. 10	Yes	No	Not stated.	Doubtful.
15 to 26 (inclus.) 27 to 38 "	Camp Sites—character as to elevation inclination, shade, shelter from wind, malaria, &c.	......	6	37	12	38	37	68	1	......	......	......	......	1	......
27 to 36 "	Camp—arrangement and condition as to crowding and cleanliness	......	3	20	25	38	56	25	26	2	......	......	......	5	......
37 to 40 "	Tents—character, ventilation, and management of	......	1	106	27	21	8	16	11	......	......	......	......	10	......
41	Bedding—supply and character of	7	26	53	65	29	7	3	......	......	......	......	......	......	......
49	Clothing—supply and character of	1	2	9	11	27	33	104	......	......	......	......	2*	1	......
50 to 57 "	Cleanliness—of person, of clothing, of camp	1	8	14	24	53	47	42	8	2	......	......	......	1	......
76 to 79 "	Water—quality and quantity	......	......	1	......	4	23	168	2	......	......	......	......	1	......
80 to 96 "	Rations and Cooking—character and inspection of	......	......	1	......	4	15	178	2	......	......	......	......	......	......
98 to 109 "	Camp Discipline—as to sutler, intoxication, and absences	......	1	8	7	25	83	71	2	......	......	......	......	3	......
111 to 113 "	Systematic Recreations and Amusements	......	......	......	......	......	......	......	......	......	......	42	156	2	......
117 to 123 "	Thoroughness of Medical Inspection of Men on enlistment	......	......	......	......	......	......	......	......	......	......	62	124	13	1
124 to 133 "	Medical Officers—sufficiency of previous qualifications and practice	......	......	......	......	......	......	......	......	......	......	176	4	7	13
134 to 154 "	Camp Hospital—ambulances, supplies, &c.	1	1	8	16	52	58	41	6	......	......	......	13	4	......

* In civilian's dress—not in military uniform.

NOTE.—This table may be read thus: Of the 200 camps last inspected previous to the 1st November, 1861, the character of the Camp Sites as to elevation, inclination, shade, shelter from wind, malaria, &c., was found to be, in six (6) cases "very bad;" in thirty-seven (37) "bad;" in thirty-eight (38) "indifferent;" in thirty-seven (37) "moderately good;" in sixty-eight (68) "good;" and in one (1) case "very good." Concerning one of the 200 regiments, no statement was made.

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MORTALITY, DISEASES, AND CASUALTIES.

Extent and General Character of Disease.—In the army of the Potomac, the average constant number of sick, per one thousand (1,000) men, has been sixty-three (63;) in the department of Western Virginia, one hundred and sixty-two (162;) in the Valley of the Mississippi, one hundred and sixteen (116.)

The average constant number of sick during the months of August, September, and October, in the regiments east and west, so far as visited, has been seventy-seven (77) per thousand. In this number all relieved from duty, from any sort of physical indisposition, however slight, are included.

At this rate, in order to secure a constantly active force of three hundred thousand men, (300,000) the nation must maintain in the field an army of about three hundred and twenty-five thousand, (325,000.)

The number of sick varies in different regiments from one-third of one (.33) per cent. to forty-nine (49) per cent.

The average length of time lost for active duty, in each case of sickness reported, has been a little more than five days, (5.18.)

The health of the volunteers of the army of the Potomac has been slightly better than that indicated by the returns respecting the health of the regular army, during the past year. The average health of the whole volunteer force in the field has been inferior to that of the regulars.

The average number of men constantly sick in the regiments from several of the States respectively, is nearly as follows:

New York,	(per thousand strong,)	- - - - -	55
Pennsylvania,	" "	- - - - -	57
Massachusetts,	" "	- - - - -	52
Connecticut,	" "	- - - - -	49
Vermont,	" "	- - - - -	88
Maine,	" "	- - - - -	124
New Jersey,	" "	- - - - -	36
Wisconsin,	" "	- - - - -	76
Indiana,	" "	- - - - -	42
Michigan,	" "	- - - - -	76
Illinois,	" "	- - - - -	156
Ohio,	" "	- - - - -	192

Data derived from regiments of States not included in the above list are too limited to be of use. The forces from Ohio and some other States have been, to a considerable extent, subject to unusual privations and exposure, during the campaign among the mountains of Western Virginia. A similar remark applies to those of Illinois, in Missouri. There is reason to think that the most sickness has occurred where regiments, raised in far northern and highland districts, have been removed to lowland, fluvial, and seaboard districts; those, for instance, from Maine and Vermont, the ridge counties of New York, and from Minnesota, being more subject to distinct disease, as well as to demoralization, or ill-defined nostalgia, than others in the army of the Potomac. The healthiest regiments, physically and morally, have been those from the seaboards, as of New Hampshire, Massachusetts, Rhode Island, Connecticut and New Jersey; those from Rhode Island being probably the most fortunate in this respect, which fact, however, is chiefly due to their superior discipline early in the campaign.

It is difficult to compare the rate of sickness of foreign armies with that of the volunteers, because it is uncertain what degree of sickness in them places a man upon the sick list. Our volun-

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teer surgeons are, undoubtedly, very accommodating in this respect, probably more so than the surgeons of the regular army or of foreign armies. It has happened in more than one instance that upon an order to advance against the enemy being given, every man of a regiment then on the sick list immediately reported himself well, was discharged, and shouldered his musket in the line of battle. It is probable that at least one-half those returned as sick by the surgeons of volunteers would do the same, under similar circumstances; that proportion being excused from duty on account of a cold in the head, severe fatigue, or a slight indigestion.

In the whole British army, in time of peace, 6.5 per cent. of the force otherwise available, is reported constantly "in hospital." Of the British army in the Peninsula under the Duke of Wellington, 1808–1814, 21 per cent. (or 9,300 of an average force of 44,500 men) was constantly "sick in hospital." The number of sick ranged from 9 to 33 per cent. of the whole force at different periods.

These rates were exceeded in the British army of the Crimea. To maintain 100 effective soldiers in the field, it there became necessary to provide for 26.6 sick men. The annual rate of mortality was 3 per cent. by wounds, and 20 per cent. by disease.

The annual rate of mortality in the British army, at home and in time of peace, was from 1.1 to 2 per cent. in the ten years preceding 1847.

The average mortality of the army of the Potomac has been, during the summer, at the rate of 3½ per cent., (allowance being made for those who die after their discharge, from causes connected with army life.) Imperfect data received from the West indicate a considerably larger rate for the whole army; probably it will not be far from 5 per cent. if sweeping epidemics should be escaped.

Mortality from *disease*, in the Royal Navy of Great Britain, is 140 per cent. greater in time of war than of peace; rising from an annual rate of 15 or 16 to one of 37 or 38 per 1,000 strength. The principal increase of the deaths in the navy, in time of war, is from disease; the amount of increase from casualties being commonly quite inconsiderable.

The following statement exhibits a classification of the cases of disease in the volunteer army during a portion of the campaign, showing, also, the per centage of casualties of all kinds (wounds, accidents, &c.) for the same period, compared with like returns from the army of the Crimea, from April 10, 1854, to June 30, 1856:

	Army of the Potomac.	Army of the West.	Army of the Crimea, Ap. 10, '54, to June 30, 1856.
Zymotic disease, (per cent.) -	61.1	76.4	69.8
Constitutional, " -	1.2	.6	.5
Local, " -	30.7	17.3	15.6
Developmental, " -	3.4	3.5	.1
Violence, " -	3.6	2.2	14.0
All cases -	100.0	100.0	100.0

Two most important facts appear on the face of this table: first, the immense disproportion between cases of disease and of violence, fully justifying all that has been asserted as to the loss an army in the field must expect to sustain from these causes respectively; and, secondly, the great excess of zymotic diseases, nearly all of which are, in a greater or less degree, preventible by proper precautions. For instance, typhus can be almost certainly averted by systematic attention to cleanliness and ventilation, smallpox by vaccination, and malarious diseases (intermittent fever, &c.) by quinine. It seems apparent, therefore, that it is within the power of Government, either by the action of the War Department or by legislation, to enforce rules that will most materially diminish the waste of efficiency by disease, and the consequent cost of the present war.

Quinine as a Prophylactic.—In connection with the subject of malarial disease, above alluded to, attention is respectfully called to the evidence collected in a report prepared for the Commission, on the value of quinine as a prophylactic against disorders of that class.

In conformity with the views therein expressed, the Commission has, at a cost of five hundred dollars, since September last, in various urgent cases, issued to regimental surgeons, at their request, two hundred and twenty gallons of the solution of sulphate of quinine in spirits ("quinine bitters") for the use of their men, under their own supervision. This has been done in the case of regiments which, from the peculiarly exposed situation of their camps, or from an inspection of their sick list, seemed in peculiar danger from disease of a malarious type. A reduction of the sick list, and a marked improvement in the health and efficiency of the men, has followed in every instance. The results of this trial induced the Medical Director of the army of the Potomac to request from the Surgeon General authority to supply quinine for use as a preventive, and not merely as a remedy; and this request has been so far complied with as to authorize its use for that purpose in certain specified regiments alone.

The following extract from a report made by Surgeon C. A. Chamberlain, of the 10th Massachusetts Volunteers, shows the effect of the use of quinine in that regiment as a preventive of disease.

After stating that malarious disease prevailed extensively among his men, Dr. Chamberlain proceeds to say:

"Believing that, by the administration of quinine to the men

"as a prophylactic, we could diminish the amount of the disease "in the regiment, I applied to the Board of Sanitary Commissioners, and was kindly furnished with twenty-three gallons of "whiskey, containing in each ounce two grains of quinine. Our "morning reports at the time show an average of fifty men "unfit for duty, besides those in hospital, of which there were "usually twenty. The medicine was given to all who were debilitated, or who showed any symptoms of approaching disease, "in doses of one to two ounces, once or twice a day. * * * * *

"Most of them grew stronger and better able to discharge their "duties, their appetites were increased, they seemed less susceptible to colds and coughs, and those who would doubtless "have suffered an attack of malarial fever, were saved from it. "The testimony of the morning reports of the sick is equally "emphatic, *bringing their number down gradually from fifty or "sixty daily to twenty-five.* Had we been supplied with a sufficient quantity, I have no doubt that our regiment would have "been saved from much of the sickness which we have since "experienced, and it would, perhaps, also have prevented the "necessity of losing one or two valuable lives.

"Immediately after our supply was exhausted, or very soon "afterwards, *the number of sick increased*, and our reports show "an average of about fifty men returned to quarters."

DISPOSITION OF THE SICK.

Of the average number on the sick list, for the entire number of regiments visited, 59 per cent. are represented as sick in quarters, 24 per cent. in regimental hospital, and 17 per cent. in general hospital.

Returns for the months of September and October, 1861, of six general hospitals at Washington, Georgetown, and Alexandria, yield the following tabulated results:

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	September.	October.
Aggregate of cases treated in hospitals	2078	1963

Proportion to every 1000 treated in hospitals during the month.

	September.	October.
Remaining at previous report	445	469
Admitted during the month	555	531
	1000	1000
Convalescents sent to Baltimore and Annapolis	187	221
Returned to duty	294	261
On furlough	8	8
Discharged from service	8	3
Deserted	6	7
Died	54	54
Remaining at end of month	443	446
	1000	1000

Proportion to 1000 remaining sick.

	September.	October.
Sick	650	571
Convalescent	350	429
	1000	1000

Thus it appears that the number of cases treated in the month of October (1963) in the general hospitals above mentioned was somewhat smaller than that of September (2078); that the proportion of patients transferred to the convalescent hospitals at Annapolis and Baltimore was somewhat greater in October (221 per 1000) than in September (187 per 1000); that a somewhat smaller proportion returned to duty; that the proportions absent on furlough, the proportions who deserted, the rates of mortality, and the proportion of cases remaining in the hospi-

tals, at the end of the respective months, do not appreciably differ. The proportion of convalescents among those remaining in hospital at the end of the month was larger for October (429 per 1000) than for September (350 per 1000.)

It also appears that the average period of continuance of patients in these general hospitals is twenty-four (24) days.

Prevalent Diseases.—The following is a statistical classification of the diseases and casualties of forty-seven regiments of volunteers and two of regulars, during periods averaging forty days for each regiment, between July 1st and October 1st, 1861.

The classification adopted is that used in the British army, and for civil registration in England, Australia, and several of the States of the Union.

The imperfect nomenclature which the regimental surgeons are obliged to adopt under the existing regulations, is necessarily followed, the Latin, however, being generally translated.

The data are taken from the consolidated returns of the regimental surgeons to the medical directors of the military departments of the Potomac, and of the West.

The present army classification and nomenclature of diseases originated a century ago, when pathological science was much less advanced than at present; it is comparable with the present system of no other army, and is universally considered by medical statists to be very defective. The adoption of a more complete and accurate system of army vital statistics is respectfully advised, analogous to and comparable with the systems in use in other civilized countries. If it is desired that the records of the medical department shall contribute to the advance of the science of preserving human life, the importance of a change by which they may be more readily compared with those of other armies and communities is too obvious to need argument.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of those the various Seaports, &c. lie, Ports where Provisions are kept being printed in CAPITALS.

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Diseases and Casualties of the Army statistically classified.

CLASS.	ORDER.	Diseases, etc.	NUMBER OF CASES TREATED. Army of Potomac.	Army of the West.	Aggregate.
		ALL CASES	15,439	12,215	27,654
		SPECIFIED CASES	15,439	12,087	27,526
		(Classes.)			
I		ZYMOTIC DISEASES	9,437	9,228	18,665
II		CONSTITUTIONAL DISEASES	193	77	270
III		LOCAL DISEASES	4,737	2,086	6,823
IV		DEVELOPMENTAL DISEASES	520	427	947
V		VIOLENCE	552	269	821
		(Orders.)			
I	1	*Miasmatic*	8,821	9,065	17,886
	2	*Enthetic*	551	132	683
	3	*Dietic*	53	30	83
	4	*Parasitic*	12	1	13
II	1	*Diathetic*	86	25	111
	2	*Tubercular*	107	52	159
III	1	*Nervous System*	1,122	276	1,398
	2	*Organs of Circulation*	51	9	60
	3	*Respiratory Organs*	817	276	1,093
	4	*Digestive Organs*	1,757	1,237	2,994
	5	*Urinary Organs*	107	33	140
	6	*Generative Organs*	97	23	120
	7	*Organs of Locomotion*	149	27	176
	8	*Integumentary System*	637	205	842
IV	1–3	Not occurring in the army	-	-	-
	4	*Diseases of Nutrition*	520	427	947
V	1, 2	*Accident* and *Battle*	551	268	819
	3	*Homicide*	–	–	–
	4	*Suicide*	–	1	1
	5	*Punishment* and *Execution*	1	–	1
		Causes not specified	–	128	128

CLASS.	ORDER.	Diseases, etc.	NUMBER OF CASES TREATED. Army of Potomac.	Army of the West.	Aggregate.
		(Diseases.)			
		CLASS I.—ZYMOTIC.			
		ORDER 1.—*Miasmatic.*			
I	1	Small-Pox	–	–	–
		Varioloid	–	–	–
		Measles	224	482	706
		Scarlet fever	–	1	1
		Quinsy	183	20	203
		Mumps	127	54	181
		Influenza	17	–	17
		Catarrh	626	171	797
		Ophthalmia	97	140	237
		Typhoid fever	156	131	287
		Typhus	1	14	15
		Congestive fever	–	18	18
		Continued fever	–	39	39
		Erysipelas	37	16	53
		Carbuncle	81	4	85
		Dysentery	618	527	1,145
		Diarrhœa	3,667	3,362	7,029
		Cholera morbus	259	23	282
		Cholera Asiatica	1	–	1
		Intermittent fever	1,178	2,868	4,046
		Remittent fever	639	839	1,478
		Yellow fever	-	–	–
		Rheumatism	720	163	883
		All other fevers	190	193	383
		ORDER 2.—*Enthetic.*			
I	2	Gonorrhœa	308	63	371
		Syphilis	159	57	216
		Bubo	54	6	60
		Stricture of urethra	29	3	32
		Cachexia	1	3	4
		ORDER 3.—*Dietic.*			
I	3	Scurvy	4	21	25
		Alcholism	49	9	58
		ORDER 4.—*Parasitic.*			
I	4	Worms	12	1	13

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Class.	Order.	Diseases, etc.	Number of cases treated. Army of Potomac.	Army of the West.	Aggregate.
		CLASS II.—CONSTITUTIONAL.			
		ORDER 1.—*Diathetic.*			
II	1	Gout	1	-	1
		Lumbago	73	19	92
		Anasarca	10	6	16
		Cancer	-	-	-
		All other diseases of this order	2	-	2
		ORDER 2.—*Tubercular.*			
II	2	Scrofula	14	7	21
		Phthisis, (consumption of lungs)	51	19	70
		Hæmoptysis	21	11	32
		Anæmia	21	15	36
		CLASS III.—LOCAL.			
		ORDER 1.—*Nervous System.*			
III	1	Apoplexy	3	-	3
		Headache	281	51	332
		Inflammation of Brain	7	-	7
		Chorea, (St. Vitus' dance)	3	-	3
		Epilepsy	29	7	36
		Sun-stroke	31	7	38
		Spinal irritation	9	-	9
		Mania	3	-	3
		Melancholy	7	5	12
		Neuralgia	120	73	193
		Paralysis	4	1	5
		Nyctalopia	1	-	1
		Hemeralopia	-	1	1
		Retinitis, (inflammation of retina)	97	-	97
		Iritis	5	1	6
		Amaurosis	-	1	1
		Cataract	4	-	4
		Earache	105	6	111
		Otitis, (inflammation of ear)	67	8	75
		Otorrhœa, (discharge from ear)	75	1	76
		Deafness	10	2	12
		Delirium tremens	12	8	20
		Nostalgia, (home sickness)	-	-	-
		Toothache	185	73	258
		Tetanus	-	2	2
		All other diseases of this order	64	29	93

Class.	Order.	Diseases, etc.	Number of cases treated. Army of Potomac.	Army of the West.	Aggregate.
		CLASS III.—LOCAL—Continued.			
		ORDER 2.—*Organs of Circulation.*			
III	2	Aneurism	-	-	-
		Angina pectoris	2	2	4
		Carditis	9	-	9
		Endocarditis	1	1	2
		Pericarditis	3	-	3
		Inflammation of Vein	-	1	1
		Varix	19	4	23
		Hæmatocele	2	-	2
		All other diseases of the organs of circulation	15	1	16
		ORDER 3.—*Respiratory Organs.*			
III	3	Asthma	20	3	23
		Bronchitis acute	350	140	490
		" chronic	65	14	79
		Laryngitis	22	2	24
		Pleurisy	112	29	141
		Pneumonia, (inflammation of lungs)	45	41	86
		Hydrothorax	-	-	-
		Epistaxis, (bleeding at the nose)	27	-	27
		All other diseases of respiratory organs	176	47	223
		ORDER 4.—*Digestive Organs.*			
III	4	Constipation	629	505	1,134
		Colic	334	82	416
		Dyspepsia	158	19	177
		Enteritis, (inflammation of bowels)	19	2	21
		Gastritis, (inflammation of stomach)	39	18	57
		Hæmatemesis	8	2	10
		Inflammation of liver, acute	38	218	256
		" " chronic	32	42	74
		Fistula	35	-	35
		Jaundice	33	50	83
		Peritonitis	15	-	15
		Splenitis, (inflammation of spleen)	2	30	32
		Hernia	97	9	106
		Hæmorrhoids	141	33	174
		Prolapsus ani	12	-	12
		Ascites	1	-	1
		Other diseases of digestive organs	164	227	391

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CLASS.	ORDER.	Diseases, etc.	NUMBER OF CASES TREATED. Army of Potomac.	Army of the West.	Aggregate.
		CLASS III.—LOCAL—Continued.			
		ORDER 5.—*Urinary Organs.*			
III	5	Calculus	10	–	10
		Inflammation of bladder	6	1	7
		Diabetes	6	–	6
		Enuresis	7	5	12
		Ischuria et Dysuria	23	10	33
		Inflammation of kidney	25	8	33
		Ulcus penis non syphiliticum	19	1	20
		Other diseases of the urinary organs	11	8	19
		ORDER 6.—*Generative Organs.*			
III	6	Varicocele	27	2	29
		Orchitis	63	19	82
		Sarcocele	2	–	2
		Hydrocele	5	2	7
		ORDER 7.—*Organs of Locomotion.*			
III	7	Hydrarthrus	17	2	19
		Anchylosis	13	–	13
		Exostosis	4	1	5
		Necrosis	3	–	3
		Other diseases of this order	112	24	136
		ORDER 8.—*Integumentary System.*			
III	8	Abscess	133	51	184
		Whitlow, or felon	79	6	85
		Phelgmon	63	20	83
		Ulcer	116	50	166
		Tumor	7	–	7
		Other diseases of the integumentary system	239	78	317
		CLASS IV.—DEVELOPMENTAL.			
		ORDER 1-3.—(Not applicable to the Army.)			
		ORDER 4.—*Diseases of Nutrition.*			
IV	4	Atrophy and debility	520	427	947

CLASS.	ORDER.	Diseases, etc.	NUMBER OF CASES TREATED. Army of Potomac.	Army of the West.	Aggregate.
		CLASS V.—VIOLENCE.			
V	1	Burn, scald	20	5	25
		Concussion of brain	5	–	5
		Compression "	1	2	3
		Contusion	135	102	237
		Fracture	15	6	21
		Frost	1	1	2
		Dislocation	21	14	35
		Partial Dislocation	51	33	84
		Lacerated or contused wound	84	24	108
		Wound by puncture	23	8	31
		Gunshot wound	50	18	68
		Poison	6	5	11
		Wound by incision	60	36	96
		Bite of Serpent	–	–	–
		Other injuries of this class	79	14	93
V	4	SUICIDE	–	1	1
V	5	PUNISHMENT AND EXECUTION	1	–	1
		Diseases not specified	–	128	128

On the next page is a table by which the distribution, according to Statistical Classes, of the diseases and casualties of the same portion of the forces of the United States (1861) may be compared with those of the British army when in the Crimea.

Number of Diseases and Casualties of each Class and Order to 1,000 cases treated.

CLASS.	ORDER.	DISEASES, ETC.	Army of Potomac.	Army of the West.	Total.	Army of the Crimea, April 10, 1854, to June 30, 1856.
		ALL SPECIFIED CASES............	1000	1000	1000	1000
I		ZYMOTIC DISEASES......................	611	764	678	698
II		CONSTITUTIONAL DISEASES............	12	6	10	5
III		LOCAL DISEASES.........................	307	173	248	156
IV		DEVELOPMENTAL DISEASES	34	35	34	1
V		VIOLENCE..................................	36	22	30	140
		(Orders.)				
I	1	*Miasmatic*................................	571	750	650	673
	2	*Enthetic*..................................	36	11	25	23
	3	*Dietic*....................................	3	3	3	2
	4	*Parasitic*.................................	1	-	-	-
II	1	*Diathetic*.................................	5	2	4	3
	2	*Tubercular*...............................	7	4	6	2
III	1	*Nervous System*.........................	73	23	51	25
	2	*Organs of Circulation*.................	3	1	2	2
	3	*Respiratory Organs*....................	53	23	40	16
	4	*Digestive Organs*......................	114	102	109	29
	5	*Urinary Organs*.........................	7	3	5	1
	6	*Generative Organs*.....................	6	2	4	-
	7	*Organs of Locomotion*.................	10	2	6	1
	8	*Integumentary System*.................	41	17	31	82
IV	4	*Diseases of Nutrition*..................	34	35	34	1
V	1	*Accident* and }	36	22	30	15
	2	*Battle* }				114
	3	*Homicide*.................................	-	-	-	-
	4	*Suicide*...................................	-	-	-	11
	5	{ *Punishment* and *Execution* }	-	-	-	-

NOTE.—This table may be read thus: Of every 1000 cases of disease and casualty occurring in the army of the Potomac, 611 were of the class called the Zymotic, (comprising epidemic, endemic, and contagious diseases.) 571 of these Zymotic diseases were of the Miasmatic order.

Tendencies of Disease.—Diseases of a malarial type, which till recently have most given occasion for anxiety, are now beginning somewhat to decline. On the other hand, there is a slight but appreciable increase in cases of disease appropriate to the winter months, as severe colds, inflammations, pulmonary affections, and acute rheumatism.

Typhus.—To this must unfortunately be added a decided increase of typhus fever. This term is used to indicate not the typhoidal aspect occasionally assumed by other forms of disease, but the formidable and infectious disorder, known, according to the conditions that produce it, as "camp fever," "ship fever," "hospital fever," &c. Its appearance is traceable to the natural disposition of soldiers to shut themselves up in their tents or huts as much and as closely as possible in cold weather. In many camps they have already been allowed to commence a system of suicide by excavating the ground within their lodgings, and throwing up banks of earth against their walls or curtains. This practice, which, as is well known, occasioned a great loss of life in the British army during the Crimean war, should be at once forbidden, and full ventilation of tents at night made compulsory, even at some real or imaginary expense of comfort. The Inspectors of the Commission are unable to act with adequate effect against this danger. An extensive outbreak of typhus would be exceedingly demoralizing as well as destructive, and it would be better that double or triple the usual allowance of blankets and of flannel shirts should be distributed to the men in camps, even if the issue should be left behind or thrown away at the first movement, than they should be indulged in their disposition to burrow or seal themselves in their lodgings.

Measles and Small-Pox.—Measles and small-pox are also common, the latter sufficiently so to justify uneasiness. Inspectors

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of the Commission have been called upon by regimental surgeons almost daily during the last month, for a supply of vaccine virus, the reason assigned by them being that it could not be obtained from the Medical Bureau. The supply at Washington, under the control of the medical authorities, was reported to be entirely exhausted on the 6th inst. There has been no general re-vaccination in the army, and many regiments are now in serious danger from this disease.

The Commission has constantly urged the importance of attention to this subject, and has been partially able to supply the existing deficiency, by purchasing and issuing to regimental surgeons the vaccine matter they stated themselves unable to obtain from the regular sources. Its organization and means are, of course, not sufficient to comprehend the whole army. It has, however, provided for the vaccination of more than twenty thousand men.

Most cases of small-pox that have occurred in the army of the Potomac are attributed by the regimental surgeons to the absence of means for a proper isolation of the sick. Small-pox patients have been conveyed to general hospital in the ambulances and on the cushions used by the sick and wounded generally. What is still more unfortunate, all cases of eruptive disease have hitherto been accommodated in one special hospital. In this hospital, overcrowded* and most imperfectly

* The overcrowded condition of the hospital has frequently led to the discharge of patients before their convalescence was established. While this report is preparing, the following statement is made by an inspector, in connection with his return for a New York regiment:

"I observed the funeral of a soldier in progress, and asking for a history of his case, received the following statement from the colonel and surgeon: A few days previous he had been sent to the hospital for eruptive diseases at 'Kalorama.' He was, when sent, in the early stages of measles. On the evening of the day thereafter, to the surprise of the surgeon, he reappeared in camp, in an exhausted and distressed condition. He said that he had

provided with bedding and supplies of every description, all cases of eruptive disorders have been placed in close juxtaposition and without adequate precautions against the communication of small-pox to patients under treatment for other diseases.

As a natural consequence of this oversight, several instances have occurred during the last two months in which patients discharged from this hospital cured of measles, &c., have, on rejoining their regiments, been attacked with small-pox, apparently contracted in hospital, and have communicated it to their comrades.

The following cases of small-pox have been reported to the Commission by the surgeons of the respective regiments, as directly traceable to this cause, viz:

In the 8th regiment	Maine Volunteers	....	7
8th "	New Jersey "	....	3
1st "	New York Artillery	....	3
Harris's Light Cavalry		....	2
7th regiment Wisconsin Volunteers		....	9
19th Indiana Volunteers		....	5

And it is to be feared that the list could be enlarged by special inquiry.

The disease has been communicated to the 4th Pennsylvania cavalry by one of these regiments encamped near it. Of the nine men belonged to the Wisconsin regiment, three have died, and the same number of the Indiana regiment. In the 8th regiment of Maine Volunteers, the disease communicated to them broke out when they were on the eve of their depar-

been discharged from the hospital, and, in the evening of a December day, obliged to walk back to his regiment. He was immediately taken to the regimental hospital, and assiduously attended upon. But notwithstanding all efforts to save his life, he died during the same night from bronchial and laryngeal congestion consequent upon exhaustion and exposure."

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ture from Annapolis for Port Royal, and the most serious mischief was only prevented by the energetic action of Dr. Cooper, the Medical Director of that expedition, who instantly transferred all who had been in any way exposed to infection from camp to the navy yard. Nevertheless, the 21st Massachusetts regiment, then engaged in guard duty at the navy yard, was infected, and up to the 28th November, twenty-five cases of variolous disease had occurred among the troops at Annapolis, five of which proved fatal.

The 8th Maine did not entirely escape the disease even after leaving all supposed to be infected behind. The last arrival from Port Royal brings news of the death of one member of that regiment, and of three deaths in the Michigan 8th from varioloid.

MILITARY HOSPITALS.

At the close of the October session of the Commission it was understood that Government would at once commence the erection of two cheap temporary model hospitals at Washington, in conformity with plans carefully prepared by a committee of the medical members of the Commission, and approved by it as embodying the latest results of sanitary science. These plans have been formally approved by the Quartermaster General, the Commander in Chief, and the Medical Director of the army of the Potomac, and the ground for the example buildings has been staked out. But their erection is not yet commenced. As the Commission believe that a large amount of hospital space of the character provided for in these plans is urgently demanded from considerations of economy as well as of humanity, it is hoped that there will be no unnecessary delay in their completion and equipment.

Defects in present Hospital Arrangements.—The defects and sources of mischief in the general hospitals at and around Washington and elsewhere, which have been under consideration by the Commission at each of its sessions, and against which it has repeatedly remonstrated, continue without material change. An unfortunate personal difficulty between two medical officers of high position is believed to stand in the way of the measures necessary to bring these establishments up to anything approaching the lowest standard that would be tolerated in any civil hospital.

No fact in sanitary science is better established than this, that old buildings, such as hotels, academies, store-houses, &c., are, from their want of systematic ventilation and other reasons, most unfit to be used as hospitals on any large scale, and that, even in inclement weather, tents or the rudest shanties are preferable. During warm weather, while every door and window is kept open, especially if the buildings are newly occupied, the evil is less felt; but in the winter months, when doors and windows are sure to be kept closely shut, it is almost certain to show itself in the form of hospital fever, erysipelas, and other formidable diseases, and in the general depression and tedious convalescence of those patients who escape them. The Commission has formally applied to the Medical Bureau to take steps to improve the ventilation of these buildings occupied as hospitals near Washington. Some steps have been taken to this end, but they are reported by the Inspectors of the Commission to be inadequate.

Complaint is made by officers of the Medical Bureau that regimental surgeons are tardy in sending their sick to general hospitals—that they are often detained in regimental hospitals till past cure. A large portion of the mortality in general hospitals is thought to be accounted for by this alleged fact.

This tardiness is in many cases to be explained by the feeling

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of discouragement frequently expressed by regimental surgeons in regard to general hospitals. Men sent to these establishments when laboring under the severest forms of disease are reported to have been frequently turned from their doors, after a long and tedious journey, and sent back to their regiments, because the hospital was full, or because there was some formal defect in their papers. In some instances, such men have spent the night in an ambulance at the hospital door.

Relations between General and Regimental Hospitals.—It is manifest that the relations between general and regimental hospitals, and between the surgeons of regiments and those in charge of general hospitals, are in an unsettled condition, which practically leads to great suffering and the loss of many lives.

Technical Difficulties in the Hospital System.—Mere technical defects and irregularities in the permits for admission to general hospitals, and also in the requisitions of regimental surgeons for their medicines and other supplies, are the daily cause of much mischief, and of what seems most unnecessary suffering.

This will be best illustrated by a statement of a single case which happens to be reported by the surgeon interested while this portion of the report is in preparation. It is by no means of peculiar or unusual hardship, and is merely a specimen of hundreds in which the Commission has been appealed to for relief.

A volunteer surgeon, whose regiment is encamped at a distance of several miles from the depot of military supplies for his division, and who has in his hospital a large number of sick requiring his constant personal attention, applies to the proper officer for a hospital stove. His requisition is in all respects regular, except that he has forgotten or neglected to get it countersigned by the

general commanding his brigade. It is, therefore, handed back to him for correction. He returns to camp. After spending at least another day in pursuit of this officer, he succeeds in finding him, in getting access to him, in gaining his attention, and obtaining his approval and the required signature. He devotes another day to another expedition to headquarters with his wagon for the transportation of the stove, and presents his requisition as amended. The name of the brigadier general appended to it is well known. But the requisition is still defective. The general has hastily subscribed his name in the proper place upon the printed blank, but has neglected to append his title. For this reason, as the surgeon is given to understand, the stove cannot be issued, and he goes back to camp without it to spend two or three days more in pursuit of the general.

Whether the sick men in this regiment sustained serious harm or any harm from the absence of the surgeon, or for want of the stove, it is needless to inquire. They certainly may have suffered fatally. Unless the surgeon considered a stove necessary for them, it is to be presumed he would not have taken all this trouble to procure one. But many analogous cases have been reported to the Commission, in which hospital patients were in imminent danger from like delays, and in which the Commission has supplied from its own stores the few dollars' worth of necessaries required to save them.

There is little room for doubt that many lives have already been lost from mere technical and formal obstacles to their preservation. It is respectfully submitted that some remedy should be applied to this evil. The inevitable consumption of life in military hospitals is sufficiently appalling without any increase from merely artificial difficulties. Official forms and rules are indispensable to the Medical Bureau and Quartermaster's

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Department, as to every other department of Government, and all who hold official relations with either, are in duty bound, as rapidly as possible, to inform themselves as to the details of its system, and govern themselves accordingly. But if this system be not adapted to the new order of things, and to the wants of the volunteer army—a question on which it is not intended to express an opinion—it seems plain that the system should be changed.

If the regulations to which surgeons must conform before they can obtain medicines for their patients be too complex and elaborate for the comprehension of the average volunteer surgeon, without military education or experience, the interests of half a million volunteer soldiers require that these regulations be revised and simplified, even at some little expense of official precision, and of checks against waste and improvidence.

If, on the other hand, these regulations be in fact fairly within the comprehension of any man of ordinary capacity who will take the trouble to study them attentively and learn his duty, volunteer surgeons should be expected and requested to comply with them, and any failures to do so, in matters involving the health or comfort of their patients, should subject them to military discipline.

A more liberal discretionary power should also be expressly vested in the Medical Bureau, in directors of hospitals, and in certain easily accessible officers of the Quartermaster's Department, to waive strict technical accuracy in requisitions for hospital supplies and in hospital permits, whenever they are satisfied that the interests of the service will suffer no substantial detriment.

MEDICAL AND SURGICAL SERVICE OF THE ARMY.

Regular Service.—Admission to the medical staff of the regular army is attained through a successful examination by a board of

army surgeons appointed by the Surgeon General on the order of the Secretary of War. The candidates approved by the board are entitled to appointment as assistant surgeons in the order of merit as vacancies occur. The test of fitness imposed by these army boards of examination has hitherto been a thorough one, and has secured to the service young men of more than average ability, who only need encouragement to advance in professional attainments, in order to maintain an eminent position as scientific physicians.

Unfortunately this encouragement is not afforded them. The policy of the Government has not heretofore been such as to develop a high degree of professional acquirement. The assistant surgeon, as soon as he is commissioned, has generally been sent to a distant frontier, where he serves for several years as physician at a small military post, the garrison of which rarely consists of more than two companies, often of one of only ninety men. As soon as convenient after five years' service, he has, after a short furlough, been submitted to examination for the grade of surgeon, which terminating in his favor, he is transferred to another frontier post, where he again passes several years without an opportunity of visiting any seat of medical learning, or of renewing by dissection, as he only can at a medical centre, his familiarity with practical anatomy. During most of this time his experience is, in many instances, limited to a small amount yearly of indigenous disease, and a few trifling accidents, and he is thus practically unfitted for professional responsibilities of a wider range.

The administrative duties of his office tend, at the same time, to interfere with the proper exercise of the higher scientific duties of his profession, and the careful preparation of a detailed monthly report often gets to be considered more creditable than the prevention, by professional foresight, of an epidemic. Thus the army surgeon, by the time he reaches middle life, is in danger of becoming a mere routinest, mindful rather of the forms of business than of scientific advancement.

It is highly creditable to the medical corps of the army that this tendency of the system has been so well resisted by many of its accomplished members, and yet that such is its tendency can hardly be denied.

But the evil is not without remedy. The head of the Medical Bureau should be allowed to permit the surgeon, after stated periods of service, to devote a few months at some centre of medical instruction, where, by association with the learned and the progressive of his profession, his own ambition would be stimulated, and his professional knowledge extended. The British Government thus systematically detaches its medical officers from duty, that they may refresh and extend their knowledge by attendance on lectures, and by resorting to other means of instruction.

Other branches of the service have the stimulus to improvement, and the opportunity of securing it afforded by occasional furloughs, for the purpose of studying the art of war. The country has not forgotten the late military commission to Europe, the experience of which must have greatly enhanced the resources of its present commanding general. Was an army surgeon ever sent to Paris or Vienna to add to his scientific knowledge? The tendency of all work as a matter of routine is to dwarf the intellect and unfit it for broader views. Hence the greater need of occasional special culture. Beside the reasons which humanity urges in favor of securing the highest efficiency to the medical corps, there exists a claim to consideration in the fact, that, unlike the officers of the purely military arm of the service, who have been educated by Government at its Military Academy, the medical officers have educated themselves in an expensive learned profession.

The service could hardly fail to be benefited also by a reorgan-

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

ization which should create a body of inspectors-general, selected from the army surgeons, with increased assimilated rank, whose business it should be to inspect the condition of all camps, hospitals, barracks, stores, and supplies, and keep the head of the bureau constantly informed as to the sanitary condition of the army, and the provision for its needs, each season and station frequently having its special wants. This feature of organization, the necessity for which is recognized in every European army, seems necessary to conform the medical department to the purely military departments of the service, thorough inspection being elsewhere the stimulus to efficiency, the remedy for neglect, and the only means by which abuses will be removed. This function of inspectors-general is now blended with that of medical directors, who, being administrative officers on the staff of the commanding general, cannot command time for the thorough and close examination which, as experts, the inspectors-general should be required to make.

More frequent reports, made up of other than purely statistical matter, embracing reflections and investigations, as well as records of cases, would, if called for by authority, and circulated in and out of the army, furnish a valuable stimulus to the laudable ambition of the army surgeon.

Volunteer Service.—The surgeons of the volunteer army have been received, with its other officers and its privates, from civil life, either with or without examination. Where examination has been had, it has varied in degree, from the rigid tests imposed on candidates by the State examining board of Vermont, to a careless weighing of merit by which the imperfectly qualified impostor has not been found wanting. In most instances the colonel has nominated the surgeon, who has afterward been confirmed by the Governor of the State, with the approval of an examining board. Practically, the result is better than could

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

have been expected. About seven-eighths (7-8ths) of the surgeons and their assistants—and this is about the proportion who have undergone examination—seem to the inspectors of the Commission to be fairly qualified for their duties.

There are notable exceptions, however, to this general rule of competence. Two surgeons confessed that, until they were supplied with instruments by the Government, they had never seen an amputating knife. But the average grade of qualification, founded on both scientific attainment and practical experience, is reasonably high.

The fairly qualified surgeon is attached to his regiment, which has reached the column of the army of which it is to form a part. What facilities are his in the administration of his office? Having overcome the difficulties in the way of securing hospital tents for his sick, and recovered from his vexation at being denied one-fourth of the articles of medicine and of furniture, for which he had made requisition in conformity to the supply table, he endeavors, as best he may, to execute his trust. Shall he treat the sick as far as possible in the regimental hospital in camp? He often finds himself cut off from the use of medicines on which he has been accustomed to rely, (they are not mentioned in the supply table for field service,) and cannot obtain others, whose importance is recognized, in sufficient quantities from the medical purveyor. His instruments are often very poor; not at all fit for the uses for which they were designed. He finds the regimental quartermaster and the brigade commissary, both unwilling to be bankers for the Government, when he asks them to purchase, on account of his hospital fund, which from the savings of his rations he has accumulated on paper, such nutritious food as he may require for his sick. Often for that purpose no funds are available.

Shall he not then send all but the lightly sick to general hospital?

It is, perhaps, not the best place for them. The fever patients will not be benefited by the ride of six or eight miles in a jolting ambulance, and they cannot have, in the old public house or the narrow rooms of seminaries, now misnamed hospitals, the free ventilation so essential to them, which the regimental hospital tent affords.

But to secure to them more prompt supplies of appropriate medicine, and more varied and suitable food, and to avoid embarrassing the rapid movement of the regiment liable to be ordered forward, he applies to the medical director for a permit which shall admit his dozen most sick men to the general hospital, in the nearest town. That he sometimes meets delay in securing it, is not strange when regard is had to the amount of accommodation in the general hospitals and the numbers already there, together with the number in camps ill enough to require the surgeon's advice, and to be nursed in the hospital tent. By the statistics gathered by the Commission, it appears that nineteen men in each thousand enlisted are on an average constantly sick in regimental hospital. Could one quarter of that number find place in the general hospitals on the Potomac, for instance, in addition to their present population?

As the character of the regimental hospital must vary according to the mobility of the regiment, the season, the locality, the prevalent diseases, the proximity to available general hospitals, etc., a larger discretionary power should be accorded to the surgeon. The facility of adaptation to varying circumstances is an essential feature of a good hospital system.

The mutual relations of the surgeon and his assistant need to be more clearly defined.

The surgeon is at loss, moreover, as to his relation to the

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

surgeon of brigade, whom he finds on the staff of the brigadier general. The authority of that officer is very imperfectly defined, and he may often claim more than would be readily conceded.

To make the medical and surgical service of the volunteer army as efficient as the country has a right to expect it to be, there seems to be required a uniform and thorough examination of candidates for the post of surgeon and assistant surgeon, by a central board of United States army surgeons, if need be. This is the more important from the practical difficulty encountered in getting rid of incompetent surgeons. It is not an unknown thing for a board summoned to test the qualifications of a medical officer known to be unfit for the discharge of his duties, to report him as qualified, after which only a court martial can separate him from the service, and this he can easily avoid.

More ample provision should be made for the sick, both in camp and town hospitals. The supply table for the former should be revised.

It is submitted, indeed, that the entire medical supply table for post, field, and general hospitals ought to be carefully examined and revised by a competent board; and that, if it be found in any respect below the requirements of the latest and most enlightened medical science, it should be brought fully up to that standard. Surgeons of both the regular and volunteer forces constantly apply to the Commission for medicines and surgical and other appliances which they deem necessary for their patients, but which they cannot obtain through official channels. Argument is unnecessary that our soldiers, when suffering from wounds received, or disease contracted, in the national service, are entitled to expect from the nation the benefit of everything that the highest medical and surgical science can give them.

Transportation.—Transportation for the Medical Department of the army is at present very deficient, irregular, and bad of its kind, and should be improved and systematized. Instances have been credibly reported to the Commission, in which sick and dying men have been packed together in cars and canal boats, and detained for hours on their way, in a manner that (unless it arose from unavoidable accident) can only be characterized as shocking and inhuman. The Government two-wheeled ambulance, whether considered as a conveyance for the sick and wounded, or as a transport wagon, is too bad to be continued. In its place several additional four-wheeled ambulances should be given to each regiment, three or four horse-litters of the form shown in Delafield's report on European armies, figures 75 to 78, pending some better invention, and a supply of pack-mules with hampers; as wagons will often be impeded, broken, and rendered impracticable, in the rough roads, gullies, streams, and sloughs, constantly met in our Southern States.

These articles should, of course, be the exclusive property of the Medical Department, and a considerable proportion of the transportation belonging to the medical service of each command should be kept near the stationary or moving depôt of the Medical Purveyor of the Corps d'Armée, in order that requisitions, by courier or telegraph, may be immediately filled and despatched. (See Appendix: "*Ambulance.*")

VOLUNTEER HOSPITAL, AND OTHER SUPPLIES.

The Commission did not, at first, contemplate furnishing hospital and other supplies to the army on any large scale, but confined itself mainly to the duties of "inquiry and advice" assigned it by the Secretary of War. It could not refrain, however, without doing violence to the human sympathies of its members, from supplying some few of the more pressing wants which they saw existing in the military hospitals of Washington and elsewhere. The absence of any hospital fund already referred to made these wants remediless, except by the Commission, or more properly, by the generous and patriotic people of the loyal States, whom the Commission represents as their agent and almoner.

The Commission thus found itself in a manner obliged to overstep its strict duty, and was induced to employ a number of experienced young men as hospital dressers; to provide for the washing of the clothing of patients and of the hospital bedding, bandages, and towels; to purchase water-beds for patients who had undergone amputation, and whose surgeons certified that they could not recover without them; to provide nurses possessed of skill for the handling of badly-fractured limbs; to engage the services of barbers to be constantly employed in the hospitals; to supply, from time to time, some small amount of stimulants, and medicines, and surgical appliances to surgeons who were unable to obtain them from the Medical Bureau, either from their own excusable ignorance of official forms, or because the stock at the disposal of the Bureau was exhausted; to provide some means of recreation for men with tedious wounds, and convalescents; to furnish letter paper, envelopes, pens, ink, and postage stamps, or obtain franks, for those wishing to communicate with their friends, or with the friends of more feeble comrades, etc., etc.

The distribution of stores, clothing, bedding, &c., to the hospitals, and occasionally and on special emergencies (as after the engagement at "Ball's Bluff") to soldiers in the field, has now become a recognized function of the Commission. It assumed it with the less reluctance, that some central agency was indis-

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

pensable to prevent a distressing waste of the supplies which the loyal women of the country were diligently providing for the army. Soldiers of one regiment were found to be over supplied, and throwing away the surplus or bartering it for liquor, while the hospital of some neighboring regiment was without beds, and its patients without a change of clothing.*

The Commission has, therefore, for some months past held itself ready to receive and to distribute where most required, among the soldiers of every portion of the army, all supplies, especially of hospital stores, which might be forwarded to its depots by the humane and charitable societies that are working for the army in every northern city, town, and village.

These supplies have been forwarded to it in large quantity.

The Quartermaster General having advertised for blankets from the private stocks of citizens, and having become acquainted with the method of action adopted by the Commission, has also directed that all blankets which shall thus be obtained by his agents shall be placed in the stores of the Commission, for gratuitous distribution, where found to be needed by the sick.

Depots of the Commission.—The principal depots of stores for the Commission are in New York, (under charge of the "Woman's Central Relief Association," of New York;) at Bos-

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* As this is being written, word is received from the quartermaster of the Second Regiment New Hampshire Volunteers, that he has three or four tons of hospital stores which have been presented to the regiment, but of which it has no need, and which he finds it impossible to transport. As the regiment is ordered to move, he desires the Commission to relieve him of them. On the same day an urgent request has been received from several other regiments of the same division for much needed supplies.

Six days after the Commission had, by its agents, conveyed to the wounded at the battle of Ball's Bluff three wagon loads of comforts, the first box arrived, sent by friends at home for their relief.

ton, at Providence, R. I.; at Philadelphia; at Cincinnati; Cleveland, and Columbus, Ohio; at Wheeling, Va.; at Louisville; at Chicago; at Cairo; at St. Louis, and at Washington.

Freight.—The freight on these supplies has been in many cases necessarily paid by the Commission. This source of expense, however, will be diminished by the liberality of the directors of most of the principal railroad lines, on which supplies consigned to the Commission will hereafter be conveyed at reduced rates.

Amount of Supplies Distributed.—The demand for articles of clothing and protection for the sick has naturally increased during the past month, but the means placed by the community at the disposal of the Commission has enabled its Inspectors to keep pace with this increase. Thirty-four thousand four hundred and eighty-one articles of hospital clothing were distributed from the Washington depot alone during the month of November, besides a large bulk of unclassified articles.

The supplies thus distributed from the Washington depot have been issued to one hundred and thirty-six hospitals; twenty of which were general, and one hundred and sixteen regimental. The average number of articles supplied to each was a litte more than two hundred. About one thousand are now daily distributed from the same depot, and their value in money is not less than five hundred dollars.

At the Cleveland depot sixty-nine thousand articles have been received since its organization; and fifty-one thousand, besides several tons of articles of hospital diet, have been already issued from it to the army of the West, at various points.

From the Wheeling depot, four thousand eight hundred and fourteen articles of bedding and clothing, alone, have been distributed.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

Accurate returns have not yet been received from other depots, but there can be little doubt that the value of supplies issued to the army, by agents of the Commission, during November, amounted, at a very moderate estimate, to the sum of forty thousand dollars.

System of Distribution.—It is the duty of the Commission to prevent, as far as possible, the sacrifice of human life to matters of form and considerations of accuracy of accounts. Its method of distribution is as thorough and exact as can be maintained consistently with this duty.

This department of its business has so greatly increased of late that it has been difficult to enlarge its clerical organization with corresponding rapidity. Vouchers signed by the surgeon, or his assistant, of every regiment or hospital aided, and countersigned by an inspector of the Commission, who has ascertained that the articles supplied are actually needed, have been obtained, however, for every dollar's worth issued at all the depots directly controlled by the Commission.

Caution is exercised in the distribution of the gifts of the people, chiefly in the following particulars:

1. That they should be as fairly divided as is practicable—those most needy being most liberally dealt with;

2. That no officer shall be unnecessarily relieved from an existing responsibity to secure for all dependent on him all the supplies which it is his right and duty to demand directly of Government.

Reserve Stock of Supplies.—The reserve of stores at the disposal of the Commission is still smaller than it should be. The demand caused by the comparatively trifling engagement

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

at Ball's Bluff exhausted its supply of various articles urgently required, and obliged it to purchase what was still needed in the shops of Washington. Had this battle been followed up by a general advance, or had a general engagement on the Potomac taken place, it is morally certain that many hundred, if not thousand men would have perished for the want of hospital supplies and medicines. Neither Government, nor the Commission, nor the shops of Washington, could have furnished one quarter part of what would have been required, especially if a national victory had thrown the enemy's wounded on the hands of the Government. It is true that Government could have telegraphed to Baltimore, Philadelphia, and New York for additional supplies; but these could not probably have been obtained in considerable quantity for several days; and if only forty-eight hours elapsed before their receipt, hundreds of wounded men would have died from mere want of medicine, bedding, and bandages.

Insufficiency of Government Supplies on hand.—The Commission feels that the duty assigned it by the War Department requires it to protest, as it has already protested, against the grossly inadequate provision for the contingency of a general action which, certainly existed during the summer and autumn, and which it believes still to exist.

To illustrate the extent of this deficiency, it is only necessary to say that the Medical Bureau was obliged to call on the Commission to supply lint and bandages for a few wounded men brought into hospital after one of the petty skirmishes that occurred in September last.

The possibility of an engagement on our own soil at any moment, between two armies of one hundred and fifty or two hundred thousand men each, is so strange a novelty that we naturally fail to appreciate its inevitable consequences, and the

immense amount of human suffering which must follow it. The battle of Bull Run has not taught us the lesson, because most of our wounded were then left on the field. Few of the more serious cases reached our hospitals. We must remember that the experience of foreign armies shows that, after a well-contested battle on this scale, we must count on having, at the very least, from twenty to thirty thousand men crying to us for relief from agony.

Supplies for Men in the field.—The Commission has, by circulars and advertisements, given the widest publicity to the need of hospital supplies at all its depots, specifying particularly the nature, dimensions, form, &c., of the articles especially needed; and, as has already been stated, this appeal has been most generously answered. It has had under consideration the expediency of making a like call on the loyal women of the country for extra clothing for men in the field. After advisement with the Quartermaster General, this has been thought inexpedient, except (to a limited extent) in the West, where delays and irregularities of transportation may retard the supply through the regular channels of Government. Our soldiers are far better paid than those of any European army, and wherever these extra articles of clothing can be obtained through their regimental quartermasters, their value being deducted from the soldier's pay, it is in the highest degree unfavorable to the development of true military habits, that they should seem to be furnished them as a kind of charity.

The Commission, however, is in constant receipt, at Washington and elsewhere, of considerable supplies of this class, which it distributes in cases of emergency. (See Appendix: *Volunteer Army Supplies.*)

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

SPECIAL RELIEF TO VOLUNTEERS IN IRREGULAR CIRCUMSTANCES.

The attempt has been made to suddenly stretch a system designed to supply the wants of a well-organized army of less than twenty thousand men under thoroughly-trained officers, to make it sufficient for the wants of six hundred thousand civilians rushing together in arms, all at once, with no officers acquainted with the forms of administrative duty for an army, but only leading men from among themselves, and of their own selection, to take the duty of officers in that system. The population of a large town has been all at once set down here and there, in various parts of the country retired from the grand routes of communication, and from all adequate avenues for the supply of their subsistence. Rogues and traitors have seen their opportunity in this state of things. Fools and indolent men have been swept, in the many eddies of the grand purpose which formed the central current, into places where great wisdom, activity, and energy would have failed to meet every pressing need.

That men everywhere, throughout these wonderful multitudes, are daily suffering from the ignorance, neglect, mistakes, and impositions of their officers and of each other, is a matter of course.

The agents of the Commission, limited in numbers, and sorely limited in means, have yet been able, in ways innumerable, and in many which cannot even be alluded to by a general indication of their character, to administer some measure of assistance and relief in many thousands of these cases.

A brief description of one of the more systematic methods in which the Commission has thus more than justified all the hopes of a beneficent result which were entertained at its organization, is all that can be attempted in this report.

The main purpose had in view, in the agency referred to, has been to lessen the hardships to which the ignorance of the sick volunteers and their officers, of the forms and methods of Government, make them subject while in the city of Washington, and to provide for certain wants of the volunteers, when detached from their regiments, for which the Government arrangements had been inadequate, and which the regular inspectors of the Commission, in their visits to camps and hospitals, could not attend to.

Practically, the chief duty has been—

First. To supply to the sick men of the regiments arriving in Washington such medicines, food, and care as it was impossible for them to receive, in the midst of the confusion, and with the lack of facilities, of their own officers.

Second. To furnish suitable food, lodging, care, and assistance to men discharged from the general hospitals, or from their regiments, but who are often delayed for a number of days in the city before they obtain their papers and pay.

Third. To give assistance and information, and secure transportation to men who arrive at the railroad station in small numbers, and want to find and join their regiments. Some of these are men accidentally left behind; some are men who have been detained by order for a few days at hospitals in Philadelphia or Baltimore.

The building near the railroad station, occupied by this agency, is furnished the Commission by Government. From its occupation for this purpose on the 9th of August last, up to the 9th of December instant, four thousand and forty nights' lodgings have been furnished to seventeen hundred and ninety soldiers, mostly laboring more or less under disease, who would, if without this resource, have been obliged to sleep on the floor of the reception house or in places of great exposure. Many have remained in it several days, receiving medical care from a physician of the city, employed by the Commission.

This has been done at an aggregate expense of about fifteen hundred dollars.

This agency also aids soldiers passing through the city on their return to their regiments from general hospitals, or passing through the city on sick leave, and in various ways that cannot be classified under any general head, but which have certainly prevented a large amount of sickness and suffering.

This will be best illustrated by extracts from two reports made to the Commission by the Inspector in charge of this agency.

"When the regiments, whose sick men we had charge of, went to camps, they usually carried their sick with them, unless the men seemed too feeble to go; in which case we saw that the men were taken to a general hospital, or else we kept them in charge a few days longer, until the regimental hospital could be put into a comfortable condition.

"Sometimes the sick of a regiment just arrived occupied a separate passenger car, and remained in the car until the regiment moved; in that case we supplied them with tea and coffee and needed refreshments in the car.

"Often the surgeon of the regiment had no medicine at hand for the sick, it being locked up in his chest, which could not be reached in the baggage car. In that case we obtained for him such medicines as immediate needs required.

"When we found men from general or regimental hospitals waiting to get their discharge papers filled out, and for their pay, we took them in charge, sheltered and fed them, and if they needed help, we rendered it.

"When we found men who were too weak to bear the fatigue of going with their papers, we took charge of the papers ourselves, had them filled up, obtained the signature of the men to blank receipts for money due to them by Government, and thus, by consent of the paymaster, received the money, and paid it over to the men. This privilege could only be granted in cases of absolute necessity.

"When we found men seeking their regiments, we directed them, (from a record of the location of the various regiments kindly

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

furnished us by General Williams;) if they needed money, we gave it to them; if they were weak, obtained an order for an ambulance, or an army wagon, or a railroad pass, by which they were sent to their respective stations.

"In many cases, men who were discharged left their regimental hospitals sadly in need of clean garments, especially shirts, stocking, and drawers. In such cases, before they started for home, we made the men clean and comfortable.

"When we found men at the reception buildings in need of medical treatment, but not sick enough to be sent to the general hospital, we called in a physician, unless their own surgeon could be obtained.

"It is not the plan to consider this, in any sense, a *hospital*, but only as a place where the weak can rest and be cared for, and the sick remain awhile until they are otherwise provided for, and also where those returning home, who have no claim upon hospital, or camp, or station-house, may be sheltered if obliged to remain near the station more than six hours. Therefore, as a general thing, men will remain in the house but one, two, or three days at any given time."

* * * * * * * *

"Within the past three weeks, we had a new class, viz: men belonging to regiments moving from Washington to Annapolis for special service. A number of cases have occurred where the regiments have struck their tents and marched to the railroad station, bringing all their sick with them in ambulances, expecting to take the cars at once; but they were detained there waiting sometimes for twenty-four hours. In such cases we have immediately received the sick into the house; and there they remained until the train which was to take them was ready to start. Some nights we had as many as twenty such from one regiment, who otherwise (though just removed from a regimental hospital) would have been obliged to have slept on the floor of the reception-house, or else in the army wagons and ambulances. Many of these were men who needed all the care we could give them."

* * * * * * * *

"Sept. 11th. There were last night in the "Soldiers' Home," as we now call it, twenty-five men resting. Among them were a number of Berdan's Sharpshooters; none of them were sick enough to go to a hospital, but some of them will doubtless be saved from serious illness by two or three days of rest and care. These men represent a large class of soldiers now arriving, who come in companies of fifties or hundreds, not yet organized into regiments, and therefore having no surgeon with them. To such we feel that we can be of especial service."

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

"Aug. 12, p. m.; at 6½ o'clock, thirty men arrive, belonging to the Wisconsin 5th, in charge of a sergeant. He left them immediately to go to headquarters to get wagons to transport them to their camp. They were men sent on from the hospital at Baltimore. They had no provision for supper. We supplied them, and at 9½ o'clock they were packed into the wagons which had arrived. Had I seen the sergeant beforehand, he would gladly have let them rest for the night in the reception-house. Meantime, at about 8 o'clock, thirteen men and one woman, of the Wisconsin 6th, arrived from Baltimore hospital, without any one in charge of them. They had been merely told to go to Washington, and join their regiment. We gave them supper, made them comfortable for the night, and after breakfast they were taken to their encampment."

Dr. Grymes, the physician to the Home, in his report, dated October 10th, says:

"I have professionally treated over 400 soldiers since the opening of the house—some of them very sick. I have sent 36 to the general hospitals from the Home, and others from the depôt. I have given medicine to many who were directed to call for advice. I have furnished medicines to various regimental surgeons arriving at the station-house; and, whenever the opportunity has occurred, have conversed and advised with them upon the prevailing diseases of our section of the country; and I have informed them what disposition they could make of their sick."

Copies of reports of the inspector in charge of the agency are submitted herewith.

The general accumulation of troops around Washington has rendered this special establishment for their aid and comfort in the particulars above suggested, and in part stated, almost indispensable. Like services are everywhere rendered them, however, by the inspectors and other agents of the Commission, in every camp and military position, and the Commission hopes (should it be enabled to continue and extend its operation) to mitigate, at least in some degree, the hardships and sufferings to which raw troops under inexperienced officers are inevitably ex-

posed, by establishing or encouraging the establishment of similar agencies for their aid and comfort at all the great centres of military operation.

It has already done so at Baltimore, Cleveland, and Chicago, through its local agencies in these cities: the Secretary of the Treasury has authorized the use of the Marine Hospitals in the two latter towns for this humane object.

A single illustration is perhaps necessary, of the manner in which a few energetic and humane men, moving near the track of an army, may often chance to be able to mitigate the inevitable miseries of war by a moderate expenditure, when not hampered in making it by regard for the strict forms of action to which the regular agents of Government are confined. Such an illustration is found concisely stated in a report of Robert Collyer, who was employed, at the time of writing it, as an inspector of the commission in Missouri.

"Twenty-seven cases of fever had been embarked at Otterville, on Saturday morning, at 10 o'clock, in a box car. The men were laid in their blankets, on the floor. With the sick was laid the body of an officer, in a coffin. A single nurse, without stores, appliances, or money, could do little else than bring water to the sick. At California Station, in the middle of the same afternoon, they were stopped, to have the road open for the train carrying * * * * * * For this object they waited until one o'clock a. m. of the following day, when the word came by telegraph that it would not pass during the night. They finally arrived at half-past three, of a raw morning, at Jefferson, where I fortunately came upon them,—two already dead on the floor; the rest faint and cold. I asked the nurse what he was doing for their breakfast. He answered that he had made a requisition, and hoped that he might get food upon it by ten o'clock. I immediately got a supply of tea, coffee, bread, and meat, from the nearest public houses, and brought it to them, for which they were very grateful.

"Finally they reached St. Louis at 10 o'clock on Sunday evening, having been thirty-six hours on the road. Three men had died in the transit; a fourth followed in a few hours,—4 of 27!"

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

A vast amount of extraneous aid, it may be here noticed has been rendered to the Government in the care of the sick among the troops in Missouri, of only a portion of which any record has been kept. Since August last, two inspectors of the Commission have been engaged in camp inspection at and near St. Louis, and at other points in Missouri, and have distributed to those wanting them a large aggregate of hospital supplies forwarded from Chicago, Detroit, Cleveland, and New York.

The "Western Sanitary Commission," constituted by General Fremont, about three months since, commenced the establishment in St. Louis of hospitals for the reception of such sick as might be transported thither from the columns advancing southwest and west. Latterly, their duties have largely increased, and in co-operation with the medical authorities of the army, they have provided most comfortable quarters for about 2,500 sick, their hospitals being nearly or quite full.

The provisions thus made have been inspected by a Secretary of the Commission, Dr. J. S. Newberry, and the evidence of intelligence, industry and philanthropy which they furnished, is in the highest degree gratifying.*

DISTRIBUTION OF ADVISORY DOCUMENTS.

The Commission, having enrolled among its associate members many distinguished members of the medical profession throughout

* The arduous gratuitous labors of the St. Louis Commission, in the establishment and care of their hospitals, have necessarily engrossed most of their time and attention; and the inspection of camps, and the prevention of disease among the troops west of the Mississippi, which, in their generous self-devotion, they assumed, has proved to be beyond their power. In these circumstances, it has been determined, by the parent Commission, to extend into Missouri the same thorough system of sanitary measures now being carried out through all the divisions of our army. An associate secretary has therefore been sent to St. Louis, who will, in co-operation with the Western Sanitary Commission, and with the assistance of experienced inspectors, in the shortest time possible, investigate fully the condition and wants of the troops in Missouri, and promptly supply all needed material aid.

the loyal States, has thought it fairly within the scope of its duties to invite them to aid in the protection of the army against disease, by the preparation of papers intended to embody in a brief compass the latest results of medical and surgical science, in regard to various special points of great practical importance, as to which some of our volunteer surgeons, necessarily inexperienced in their new field of army medicine, surgery, and hygiene, and without access to libraries, may need information and advice. The duty of compiling these papers has been confided by the Commissson to leading members of the profession in our principal cities; and papers on re-vaccination, on the treatment of camp fever, on dysentery, and on certain surgical operations of importance, but not universally understood, are now completed or in progress. These the Commission proposes to print, and to place in the hands of every member of the medical staff. Though many of these gentlemen need no advice or instruction as to their professional duties, there are, doubtless, some whose patients will feel its benefit, and should a single life be thus saved, the labor will be abundantly recompensed.

RECORD OF BURIALS.

The Commission has endeavored to obtain information by which the place of burial of the volunteers who have been killed in battle, or who have died in hospitals, may be established. They have also elaborated a system of records for those dying in hospitals, and of indications of their burial place, by which their bodies may be identified; which has received approval, and been ordered to be carried out, blanks and tablets for the purpose being furnished to each regimental quartermaster.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

DISBURSEMENTS.

The following is a statement of the cash disbursements of the Commission to the 20th November, 1851.

Travelling Expenses of Inspection	$2,079 00
Compensation of Services for Inspection	3,480 36
Travelling Expenses of Commissioners	1,640 13
Office Expenses, Including Services	1,036 24
Printing and Stationery	1,823 95
Postage	397 19
Telegrams	90 29
Freight	888 66
Soldiers' Home, at Washington	1,195 00
General Hospital	2,392 74
Regimental Hospital	572 59
Store House Expenses at Washington	660 83
	$16,256 98

THE MEMBERS OF THE COMMISSION.

Of the gentlemen named as Commissioners, in your order dated June 9th, 1861, the following accepted the duty assigned them, and have continued active members of the Commission, viz:

The Rev. HENRY W. BELLOWS, D. D., New York.
Prof. A. D. BACHE, LL. D., Washington.
ELISHA HARRIS, M. D., New York.
GEORGE W. CULLUM, U. S. A., Washington.
ALEXANDER E. SHIRAS, U. S. A., "
ROBERT C. WOOD, M. D., U. S. A., "
WILLIAM H. VAN BUREN, M. D., New York.
WOLCOTT GIBBS, M. D., New York.

SAMUEL G. HOWE, M. D., Boston.
CORNELIUS R. AGNEW, M. D., New York.
J. S. NEWBERRY, M. D., Cleveland.

The Commission, under your authority, has since added to its number by the addition of the following members, viz:

GEORGE T. STRONG, New York.
HORACE BINNEY, JR., Philadelphia.
The Right Rev. THOS. M. CLARK, D. D., Providence, R. I.
The Hon. JOSEPH HOLT, Kentucky.
R. W. BURNETT, Cincinnati.
The Hon. MARK SKINNER, Chicago.
FREDERICK LAW OLMSTED, New York.

It has also appointed about four hundred "associate members" from every part of the loyal States, including many gentlemen accomplished in sanitary science, whose counsel and assistance has been found of great value. Through these associate members, auxiliary organizations have been established in our principal cities, which have rendered material service to the Commission, in supplying it with funds, in stimulating the supply of hospital material, and in the preparation of medical and surgical papers.

An expression is due of the obligations which the Commission is under, to the Major-General Commanding; the Quartermaster General, and to the Medical Director of the Army of the Potomac, for valuable advice in its deliberations.

Thanks are due, also, to nearly all the agents of Government, who have at any time had it in their power to aid the work of the Commission. In the various regiments of volunteers which have been inspected, the number of officers from which the Com-

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

mission has received information is about seven thousand. With a single exception, they have answered enquiries and received suggestions, in matters of their duty, with entire courtesy and frankness. The fact illustrates a distinguishing characteristic of this Republican Army.

IMPORTANCE OF MILITARY HYGIENE.

The experience and observation of the last five months, has only strengthened the original conviction of the Commission, of the immense practical importance to the nation, in a merely economical point of view, of a thorough system of military hygiene, and of increased precautions against the occurrence of disease. Such precautions can hardly be said to form part of our present system. The army medical staff are charged with the cure of disease; its prevention forms a most subordinate branch of their duties, if, indeed, it be distinctly recognized as belonging to them.

The views of the Commission on this subject are clearly embodied in the following extracts from a Report on Army Medical Statistics presented to the British House of Commons, (printed June, 1861):

"Reports exhibiting the results of extensive observations over a wide field will serve to measure the influences of each known cause on health, and will probably lead to the discovery of new causes, both of impaired and of vigorous life. They will every year contain new contributions to the science of health, in which the whole nation is concerned. The report will be the means of improving the health of the army. They will contribute to diminish the army's sickness, which is attended with expense as well as suffering; for a sick army is the worst extravagance in which a nation can indulge. Through the want of information, which these reports will supply, the exact amount of sickness in the army is not known; but according to past experience, it may inferred that at least *thirteen thousand* officers and men of the

present force are habitually in the hospitals, so that to have an available strength of *one hundred and eighty-seven thousand*, the country has to maintain *two-hundred thousand* of all arms. The *thirteen thousand* sick men in the hospitals cost as much as *thirteen thousand* men under arms. Here is a wide margin for economy.

"If the statistical reports help the Secretary of State for war to reduce largely the sickness of the army in peace and in war, they will, it is plain, save thousands of pounds annually in the estimates. At the same time they will effect a still more important saving: for they will save the lives of our soldiers.

"If soldiers die in battle by hundreds, they die of disease in hospitals by thousands.

"The economy of life resulting directly from the information which statistical returns supply, has been already strikingly exemplified in Jamaica, where, by a better choice of stations and sanitary arrangements, the mortality has been reduced from 13 (in 1817–1836) to 6 per cent. per annum (in 1837–1855) on the strength.

"The sickness in the field may be reduced by carefully selecting men; by letting the men when it is practicable, breathe purer air; by selecting the healthiest sites available for camps; by raising the men in their tents from the ground; by supplying them with purer water; by better arrangements for cleanliness, clothing, and the supply of food, and by better medical arrangements.

"A certain amount of insalubrity will nevertheless remain.

"As we have shown that the excessive sickness of the army involves a large amount of expense, it is evident that the diminution of that sickness will effect a great saving in peace and an enormous saving in war. For sick men are not only a loss but an incumbrance to an army. Their numbers are negative quantities. The expense of recruiting and of invaliding soldiers would be reduced by reducing the rates of mortality. Fewer men would be required, and recruits would more readily join a healthy army. The existence of an army in the highest state of efficiency would give additional security to the country without increasing the cost; the liability to an attack would be lessened; war would be waged with more chances of success, and would sooner be brought to a close by such an army than by an army

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

suffering from diseases which have hitherto infested our barracks and camps."

The object had in view by the Commission can be effectually accomplished only by the direct action of Government, through officers who can order, where the Commission can only advise. The cause our armies have to defend is alone dearer to the people than are those who have to suffer in its defence. The strength and mobility of the army cannot be sacrificed to the care of its sick and wounded. The sick and wounded should be sacrificed unflinchingly, to every unavoidable, military necessity; but all the more should they be supplied with whatever mitigation of suffering military necessities leave possible. And these should be furnished them, not as if a hard master were driving a bargain with them—as in the commutation of a board contract—but as if the love and pity of mothers, wives, sweethearts, and sisters, were exercised with the far-seeing providence, boldness, ingenuity, tact and industry of true military generalship—Surgeon-Generalship.

The duty of guarding against the defeat of our armies by disease, needs to be undertaken as earnestly, as vigilantly, with as liberal a policy, and with as resolute a determination, as any other military duty.

To secure this result, the Commission is convinced that a higher place needs to be accorded the medical staff in the organization of the army. Its relations with all departments and all ranks, as well as with the Government itself, needs to be more intimate, confidential, and influential.

Whatever and whoever stands in the way of this, the Commission wants put out of the way. But if an impression prevails

in any quarter that the members of the Commission, in their devotion to this purpose, have been over-zealous, or sought, individually or collectively, to bring it about by action not absolutely within their assigned duty, or that they have used any indirect or unworthy means therefor, that impression is without the smallest foundation in truth. Whoever seeks to promulgate it, narrows to a personal issue a question of the broadest humanity, and is without provocation or excuse for so doing, in any action of the Commission.

The one point which controls the Commission is just this: a simple desire and resolute determination to secure for the men who have enlisted in this war that care which it is the will and the duty of the nation to give them. That care is their right, and, in the Government or out of it, it must be given them, let who will stand in the way.

The Commission has no fear that its motives will be misconstrued, or its words perverted. In the life-struggle of a nation, soft speaking of real dangers and over-considerateness is a crime.

Whether the great tide of the spirit of war which now submerges our land shall be allowed to quietly subside, or whether the struggle in which we are preparing to engage shall continue so long as to establish in us the habits of thought and of life of a military nation, matters little. It matters much that, whatever betide us, we remain true to the central idea of our nation's life; that our army be one with our people, and that we accept whatever the Almighty sets before us as our duty, courageously, patiently, and with mutual helpfulness.

The members of the Commission, deeply grateful for the honored confidence which has constituted it so important an artery of the people's love to the people's army, desire nothing so much as that by a sufficient enlargement and invigoration of the proper departments, they may be relieved of the duties which they have undertaken.

While, however, their beloved Government can, with advantage, continue to accept such services as by the aid of the public liberality they are able to offer, they renew their assurances of the devoted good will with which they remain at its disposal.

By order of the Commission:

FRED. LAW OLMSTED,
General Secretary.

APPENDIX.

I.

OFFICERS OF THE SANITARY COMMISSION

President, the Rev. H. W. Bellows, D. D.
Vice President, Prof. A. D. Bache, LL. D.
Treasurer, Geo. T. Strong.
General Secretary, Fred. Law Olmsted.
Associate Secretary, J. S. Newberry, M. D.
" " J. Foster Jenkins, M. D.
" " J. H. Douglas, M. D.
Assistant Secretary, A. J. Bloor.

Actuary, E. B. Elliott.
Accountant, John Bowne.

II.

STAFF OF INSPECTION.

ATLANTIC.

J. Foster Jenkins, M. D., *Associate Secretary.*
Lewis H. Steiner, M. D., *Sanitary Inspector.*
Gordon Winslow, D. D., " "
Geo. L. Andrew, M. D., " "
Wm. M. Chamberlain, M. D., " "
George A. Blake, M. D., " "
Robert Ware, M. D., " "
Henry K. Oliver, M. D., " "

CENTRAL.

J. S. Newberry, M. D., *Associate Secretary.*
Godfrey Aigner, M. D., *Sanitary Inspector.*
C. S. Griswold, M. D., " "
A. N. Read, M. D., " "
W. M. Prentice, M. D., " "

WEST OF THE MISSISSIPPI.

J. H. Douglas, M. D., *Associate Secretary.*
Prof. Henry A. Warriner, M. D., *Sanitary Inspector.*

INSPECTORS ENGAGED IN SPECIAL DUTY.

Fred'k N. Knapp,
Henry B. Rogers,
Robert Collyer,
Thos. B. DeWalden,
J. B. Clark,
W. S. Wood.

Table IV.—To show how much of the different Stations is Tropical; how much Extra-Tropical; and in which of these the

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

III.

EXAMPLE.

Owing to the insignificant number of our regular army, and to the fact that a large part of it has been constantly engaged in scouting duties in the wilderness, the aspect of the tidy, well set-up, alert, thoroughly trained soldier, so familiar to all Europeans, is almost unknown to the native American. Of military administration, and especially of sanitary duties, our officers have rarely seen anything, even rarely read or heard anything, before they become responsible for executing them. Information about them is to be obtained from certain paragraphs of military brevity scattered among above sixteen hundred sections of the general *Regulations for the Army*, and from observation of those a little more advanced in experience. Hence the exceeding value of a good example in establishing a standard of attainment. It was precisely the same in the revolutionary war, and it was then, not until the Inspector General took a company of one hundred and twenty men, and by giving it his almost undivided personal attention for some time, personally inspecting each man twice a day, and was thus able to set before the Continental officers an example of real excellence, that the army began to assume an efficient character for offensive operations. "In a fortnight," writes Steuben, "my company knew perfectly how to bear arms, *had a military air*," &c. "I had my company of guards exactly as I wished them to be. They were well-dressed, their arms clean and in good order, and their general appearance quite respectable." * * "It afforded a new and agreeable sight for the young officers and soldiers." "Having gained my point, I dispersed my apostles, the inspectors, and my doctrine was eagerly embraced." This was in December, 1777—a year and-a-half after the war opened.

In the *Regulations* for the Continental army the police, sanitary, and administrative duties of officers are far more thoroughly defined than in the present *Regulations*, and, if they were regarded, the Continental army toward the close of the war, at least, must have had a much more creditable appearance than our present army, and been less in danger of camp epidemics. *See Kapp's Steuben.*

IV.

SOME NOTES OF AN INSPECTION OF A PART OF THE FORCES ENGAGED IN THE BATTLE OF BULL RUN.

As soon as practicable after the battle of Bull's Run, a series of seventy-five enquiries was prepared, intended to elicit information as to the condition of the troops before, during, and after the engagement, and as to the defects in the mode of providing for the necessities of the army which had been manifested in the series of movements which were connected with it. These questions were placed in the hands of the seven inspectors of the Commission, who were then employed in visiting the regiments which had been engaged, for the purpose of ascertaining and administering to their wants, and they were instructed to obtain answers to them, which would represent as nearly as possible the knowledge and judgment of the most intelligent officers and surgeons of these regiments with whom they were able to confer.

The returns received comprise about two thousand items of evidence with reference to the history of the battle, and have a certain value otherwise than from a medical or sanitary point of view. The largest part of them were collected by physicians and examiners of life insurance companies, accustomed to an exact and searching method of inquiry.

Portions of each of the twelve brigades under the command of Major General McDowell, at the time of the general advance of July 16, were visited by the inspectors.

The entire number of bodies of troops visited was thirty.

Of the twelve brigades comprising the army of the Potomac, seven only crossed the stream known as Bull Run, on the occasion of the engagement of Sunday, July the 21st, and took any active part in the main action with the enemy.

Certain regiments that crossed the stream and took important part in the action of the 21st, (as, for instance, the 69th and the 71st New York State Militia,) were removed from Washington to be mustered out of service so soon after the battle, that no reports were obtained from them.

Concerning several of the regiments visited, replies were obtained to the entire series of seventy-five questions proposed; concerning others, replies were obtained to but a portion of the series—the defect being due in some instances to neglect on the part of inspectors, in others, to inability on the part of the regimental officers consulted to give the information desired.

Skirmish of the 18th.—Of twenty-nine bodies of soldiers visited, four were actively engaged in the "demonstration" of the 18th of July, (Thursday,) at Blackburn's Ford, (across the Bull Run,) three others were engaged, but not actively, and twenty-two were not engaged.*

Engagement of the 21st.—Of the same twenty-nine bodies of troops, twenty were actively engaged in the battle of the 21st of July, (Sunday,) seven were engaged, but not actively, and two were not engaged.

Camp Guard.—The average number left as camp guard at the time of the general advance, previous to the engagements of the 18th and 21st, from each of nineteen regiments reporting on this point, was sixty-eight, (more exactly, 68.2.) From ten of the twenty-nine regiments visited, no report was made as to the number so left. The smallest number so left behind by any regiment was thirteen; the largest number so left, one hundred and fifty.

Strength of Regiments.—The average number of troops that marched for the battle field at the time of the general advance, from each of twenty regiments reporting on this point, was (as stated by their officers) eight hundred and two;† nine of the twenty-nine bodies of troops visited not reporting. The smallest number so marching was six hundred, the largest number nine hundred and fifty-one.

Last Meal.—The last meal before the battle of the 21st, of sixteen of the twenty-nine regiments, was on the evening of the day before; that is, on the evening of the 20th. Six regiments had a regular breakfast early (that is, before 2½ o'clock) on the morning of the day of the battle; two regiments breakfasted at six, and the battalion of United States infantry is reported to have enjoyed a regular meal in the woods about eleven a. m. The time of the last regular meal of three regiments is not reported, but there is reason for stating it to have been about 6 a. m.

First Movement on the 21st.—The troops, except those in the reserve, were aroused from sleep between the hours of one and two o'clock on the morning of the battle of July the 21st, the march being ordered to commence with some at two, with others at half-past two.‡

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* The thirtieth body, previously referred to, was Blenker's Brigade, which also was not engaged and which is for the present disregarded, because the returns from it are more imperfect than the average.

† This is believed to be somewhat over estimated.

‡ Those regiments which breakfasted at six were of the reserve.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

The Commissariat—The troops had been supplied at about 3 p. m., on the 16th of July, with three days' rations in their haversacks, "which should have lasted them to the afternoon of the 19th." [See report of Captain Clark, Commissary of Subsistence.] And again, in a circular from headquarters, dated at Centreville, July 20th, 1861, an equal distribution of the subsistence stores on hand was required to be immediately made to the different companies of each division. In accordance with the last-mentioned order, "160,000 complete rations were received by the army at and in the vicinity of Centreville—sufficient for its subsistence five days." (Hence there appears to have been a short interval unprovided for.)

According to the reports made to the inspectors, few companies complied fully with these orders; twenty-six of the twenty-nine regiments visited took at least a partial supply, say from one to three days' rations, under the former order; two regiments, it is said, taking "no supply," depending for food upon "forage." An insufficient supply in one case was accounted for by the statement that "they had no expectation of being called to march;" (that is, therefore did not obey the order.) In several instances it is stated that the supply of three days' rations taken by the troops was "exhausted before the close of the second day;" that is, the rations were wasted. These confessions of neglect or improvidence on the part of the volunteers are confirmed by the report of Commissary Clarke, in which it is stated that after the distribution had been properly made to the several divisions, he (Captain Clarke) knew "of several instances in which subsistence stores remained in possession of division and brigade commissaries, and of others in which provisions were left on the ground of the encampments on the morning of the 21st of July."

Distance Marched before the Battle.—The distance marched to the field of battle on the morning of the 21st by those who became actively engaged, varied from four to twelve miles; of those in the vicinity of the field but not actively engaged, the distance generally was from two to four miles, (Richardson's brigadg remaining in the position it held on the 20th, menacing the enemy at Blackburn's Ford.)

Double-Quick.—The portion of this march to the battle field which was at double-quick, was, in the case of fifteen of the regiments, from one and one-half to three miles—generally from two and a half to three miles; in the case of thirteen of the regiments there was no portion of the march at double-quick. During the battle a few of the companies, and but a few, moved at double-quick for one or two miles.

It seemed to be generally considered by the volunteers that their strength was unnecessarily and injudiciously wasted by the extent of the double-quick advance. To a certain extent this appears to be true, yet the result could hardly have been affected by it if the men had been in tolerable condition.

Degree of Vigor at Commencement of Battle.—As to the physical condition of the troops on reaching the field of battle, it is reported that eight of the regiments visited were in "fair," "excellent," "good," "best" condition;

That in eight others "the men were somewhat exhausted," "partially exhausted," evidently suffering;"

That in twelve of the regiments visited, the troops were said to be "much exhausted," "generally fatigued," "many considerably exhausted;" in six of the regiments from one to twenty were "giving out," "giving completely out," &c., one or two instances of "sun stroke" being specified.

In eight regiments none "gave out" before the battle; in from nine to eleven regiments some gave out before the battle; and concerning the remaining regiments there is no report.

(There was was an evident disposition to regard the exhausted physical condition of the men as a chief cause of the defeat.)

Causes of Exhaustion before the Battle.—As to the causes assigned for the exhaustion, it appears that of the regiments visited, it was stated that three had not suffered at all from fatigue or heat, or want of food or drink or sleep; in seventeen of the regiments "fatigue" was assigned as a cause of exhaustion; in eleven the march at "double-quick" was specified as peculiarly fatiguing; in eight of the seventeen the exhaustion is attributed more to the double-quick than to want of food and drink; in sixteen of the regiments want of food was assigned as a cause of exhaustion; in eleven want of drink was assigned as a cause; and in a few cases, the exhaustion was attributed, in part at least, to want of sleep, and to a bivouac of three or four nights in the open air, with insufficient clothing, as was the case with the Fire Zouaves, who left their blankets and rubber cloths in camp.

So much as to the condition and movement of the troops before the battle.

Time in the Battle.—The time during which the troops taking part in the battle of the 21st were actively engaged (pushing forward the enemy, or being temporarily on retreat, after first coming under fire,) appears to have varied from twenty-five minutes to six hours, being in most cases from five to six hours.

To the regiments most actively engaged the time was thought to be much shorter than actually elapsed, the five or six hours in which they were engaged seeming to the men, as they state, scarcely one hour. The time during which men stood under fire without being actively engaged themselves is, on the other hand, found to be over-estimated by them.

Degree of Vigor during the Battle.—It is claimed that in eight of the twenty-nine regiments visited, there were no symptoms of exhaustion manifest during the battle; that in eight there was evident suffering and fatigue evinced by men lagging behind, and by companies breaking up, especially after double-quick, few or none giving completely out; that in ten regiments, many (in some instances stated as high as one-fourth or one-third of the number constituting the regiment,) gave completely out, "some few dropping down in convulsions," or suffering from "sun stroke." The evidences of exhaustion in other regiments are not assigned.

Causes of Exhaustion during the Battle.—In explanation of the alleged excessive exhaustion of the men toward the close of the battle, the officers consulted in twenty-six of the twenty-nine regiments referred to, attribute it to fatigue and heat, twenty-one to lack of food and drink. All the reports which assigned insufficiency of food and drink as a cause, also assigned excessive fatigue. Six of them assign fatigue, and especially the march at double-quick, as the main cause of the exhaustion which was manifest during and just after the battle.

Cause of Retreat.—The proximate cause of the retreat is variously assigned—to the attack of fresh reserves of the enemy upon our right—to the rapid and apparently wild return of the caissons for ammunition—to the appearance of a retreat of our cavalry, who were thought by some to be riding over our own infantry, the rear guard, at the same time, mistaking them for secession cavalry, &c. Certain more organic causes of the defeat are frequently stated.

By some the defeat is attributed to the condition of the men, exhausted by excessive fatigue, and by want of sufficient food, drink, and sleep; by others, to a "feeling," on the approach of the fresh reserves of the enemy, "of the total inadequacy of a small force to compete with superior numbers supported by masked batteries." By others the defeat is attributed to "causes involving the whole command;" "not due to previous exposure and fatigue, but to the bad conduct of the battle on the part of the leaders." By others (regulars) the defeat is attributed to "inefficiency of volunteers;" by one (German) to "bad strategy and want of discipline."

Through all the regiments there appears to have prevailed the false idea of the vast superiority in point of numbers possessed by the enemy, together with

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a lack of confidence in the military skill of the leaders of the army of the Union, as compared with that of the leaders on the part of the rebels; also combined to a certain extent with a dread of meeting an invisible foe.

Officers Leaving their Commands.—In thirteen of the regiments the officers are said not to have been much separated from their commands, except in the case of wounded officers; in eleven regiments it appears that the officers were, to a considerable extent, separated from their commands, the regiments being "much scattered," "badly disorganized," "broken into fragments," the men being, in certain cases, "left entirely to themselves." Concerning five of the regiments visited, no information was given on this point. (The above report is that of the officers themselves in most cases.)

Throwing away of Arms and Equipments.—Of the twenty-nine bodies visited, twenty-two threw away or laid aside blankets and haversacks before engaging in battle. Some placed them in a pile under guard, others threw them aside carelessly, either before arriving on the field, while approaching it at double-quick, or immediately before engaging with the enemy. Three regiments threw off their blankets during the battle, and the march at double-quick on the battle field; one regiment threw aside blankets only, retaining haversacks; and three only of the twenty-nine bodies of troops visited retained possession of their blankets and haversacks during the engagement.

During the retreat, it appears from the reports of the inspectors that the men of ten regiments did not throw away any of their arms or accoutrements; that the men of nine regiments did throw away portions, no report being made relative to the course of the remaining ten regiments. There is no reason to believe that these latter averaged better in discipline than the former, and it is probable that there was some loss of arms in, at least, half of them. Colonel Keyes, of 1st brigade, 1st division, reports that his brigade bivouaced on the night of the 23d near Fort Corcoran, "every man with his firelock."

The number of muskets thrown away during the retreat was stated, in some cases, to be about fifty; generally the number is not mentioned. [A considerable portion of one regiment are reported to have exchanged their smooth-bore muskets for those of a superior kind left behind by regiments preceding.]

The blankets and haversacks of many of the regiments, especially of those actively engaged in the conflict of the 21st, were lost, being left on the field of battle wherever they were deposited before the engagement. A small number of the regiments, and a few individuals and companies in each regiment, possessed themselves again of their blankets and haversacks, it is stated, before leaving the field.

Overcoats do not appear to have been so generally lost, as many of the regiments left their camps at the time of the general advance, (July 16,) equipped in "light marching order," that is, with blankets, haversacks, and canteens, leaving overcoats in their camps. Certain of the regiments, as, for instance, the Connecticut regiments and the 2d Maine regiment, in the brigade under the efficient command of Col. Keyes, recovered much property of other regiments, including arms and other equipments thrown aside in flight, and also including the abandoned tents and camp equipage of two regiments, (of another brigade,) this latter property being secured by his troops during the continued drenching rain of the 22d. Companies in certain other regiments (as in the Massachusetts 1st) halted on retreat, and picked up blankets, camp kettles, &c., which they found thrown aside on the road. (The loss of blankets at this time led in certain regiments to a good deal of subsequent sickness and increased demoralization.)

Bad Arms.—One regiment complained of the bad condition of their smooth-bore muskets, (the altered muskets of 1840,) nipples breaking, cartridges too small, so as to drop in, or too large, so as to require to be forced in by pressing the ramrod against trees, &c., &c. This complaint does not seem to have been general, with certain regiments the smooth bores working efficiently.

Distance Travelled.—The distance traveled by the several regiments on the night of the retreat varied from twenty to thirty-five miles, generally it was about twenty-seven. The average distance of the day's advance and retreat, including movements on the field, was about forty-four miles.

Physical Condition after the Retreat.—The next morning, (the 22d,) according to the almost universal report, there were few, if any, able men in the infantry. Blistered feet, rheumatic pains, aching limbs, diarrhœa, and nervous debility being prevalent.

The physical condition of three of twenty-nine bodies of troops when visited a few days later, was reported "unaltered by exposure and retreat," "not exhausted;" the men of four regiments were reported to be not much exhausted; those of fifteen were reported to be much exhausted, "physically prostrated," "prostrated," "exhausted and worn out," "greatly affected by exposure and retreat," "terribly fatigued, could not get rested," &c. The physical condition of seven of the regiments was not stated.

Causes of Exhaustion.—The physical exhaustion of the troops was attributed to excessive fatigue, to heat, and to want of food and drink.

Extent and Degree of Demoralization after the Battle.—At the time of making the inquiries, from the 25th to the 31st of July, inclusive, it appeared that of the twenty-eight regiments visited, eight were considered by their officers not to be essentially demoralized;* one was described as "not discouraged," another "full of courage and ready for an engagement;" (1st Mass.) "*morale* good," (2d R. I.;) "in good spirits," (2d N. H.)—eight were reported to be not much demoralized, "some few dispirited, but generally cheerful and animated," "somewhat depressed and disgusted with needless (?) exposure, otherwise not much demoralized," (there is reason to think that the exposure to rain, complained of as needless, was far from needless, was in fact, essential to the protection of property;) "not much disheartened" "will re-enlist," &c.; twelve were reported "as much demoralized," "much disheartened and discouraged," "morally prostrated by the rout," "low spirits," "one-half of the regiment demoralized, majority wish to go home," "wish to be disbanded and return to fight under other leaders," "completely demoralized, discontented, unwilling to serve, because, as they allege, ill-fed and unpaid."

The degree of demoralization does not appear to be coincident with the degree of physical and nervous exhaustion.

As a rule, the best officered, the best disciplined, and the best fed regiments, were obviously the least demoralized.

Causes of Demoralization.—The demoralization was attributed, by those making answer to the inquiry, generally, in each case, to several causes combined. Among these, in fifteen cases physical and nervous prostration was mentioned; in seven cases, discouragement on account of the result of the battle, accompanied sometimes with a feeling of inadequacy to compete with superior numbers; in two cases the great mortality attendant upon the late engagements was assigned among the causes; in three cases, dissatisfaction with armament—(smooth-bore muskets;) in three, dissatisfaction with and lack of confidence in officers; in five, dissatisfaction with food; in one case, dissatisfaction on account of failure to receive from Government pay promptly for services; in two dissatisfaction in consequence of supposed needless exposure to storm.

General Summary.—From these investigations, combined with information derived from official reports of the generals commanding; from published statements in rebel as well as loyal journals; from previous investigations of the

* Subsequent reports were sometimes less favorable.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

inspectors of the Sanitary Commission as to the condition of the troops, and from other sources, it is manifest that our army, previous to and at the time of the engagement, was suffering from want of sufficient, regularly-provided, and suitable food, from thirst, from want (in certain cases) of refreshing sleep, and from the exhausting effects of a long, hot, and rapid march, the more exhausting because of the diminution of vital force of the troops due to the causes above enumerated. They entered the field of battle with no pretence of any but the most elementary and imperfect military organization, and, in respect of discipline, little better than a mob, which does not know its leaders. The majority of the officers had, three months before, known nothing more of their duties than the privates whom they should have been able to lead, instruct, and protect. Nor had they, in many cases, in the meantime, been gaining materially, for they had been generally permitted, and many had been disposed, to spend much time away from their men, in indolence or frivolous amusement, or dissipation.

It appears that many were much exhausted on reaching the field of battle, but that, supported by the excitement of the occasion, they rallied fairly, and gradually drove the opposing forces from Sudley Spring to the lower ford, and from the lower ford to beyond the Stone bridge and the Warrenton road: that, at this time, (half-past three,) when congratulated by superior officers, and congratulating themselves on having achieved a victory, and when having repulsed reinforcements sent from the extreme right of the enemy to support their retreating columns, they were just relaxing their severely-tried energies, there appeared in the distance "the residue" of the forces of General Johnston, (see McDowell's report, Dr. Nott's letter to a Mobile paper, and correspondence of Charleston Mercury,) a single brigade (Elsey's) coming from the Manassas Gap Junction railroad, marching at double-quick to engage our troops at the right who had been hotly fighting unrelieved by reserves during the day. This brigade, joined with the two regiments of Kershaw and Cash, "turned the tide of battle." (See in Richmond Dispatch, July 29, statement "of a distinguished officer who bore a conspicuous part on the field of battle on the 21st of July.")

Our troops, ignorant of the fact that they had been contending against and repulsing the combined forces of Beauregard and Johnston; and believing that this inconsiderable remnant of Johnston's forces which they now saw approaching to be his entire column; and feeling their inability, without rest or refreshment, to engage an additional force of fresh troops nearly equal in number to those with whom they had been contending during the day,—commenced a retreat, not very orderly, but quite as much so, at first, as had been the advance in which they had driven back the forces of the enemy. Their (nominal) leaders, who too often had followed them in battle, were, in many cases, not behind them on retreat.

As they retired, however, a sense of disintegration began to pervade their ranks; each ceased to rely on his comrade for support, and this tendency was augmented by the upturned wagons blocking the road, which served to completly break the imperfect columns.

The reports of the inspectors give no evidence that the panic infected the extreme left, or the reserves, to any sensible degree. It was uncontrollable only with a part of the troops on the extreme right, among whom it originated. Many at the centre and the left were surprised when the order came to retreat, and for a time considered it as merely an order to change position in view of a still further general advance. Some officers state that they "warmly remonstrated"—"too warmly, perhaps"—when they received the order to retire.*

*The history of the 2d Rhode Island Volunteers may be cited as an example of those to whom Bull Run was no disgrace. They were near the extreme *right* in the engagement. Their previous march had been as fatiguing as that of others; they were as badly off for food as others, having nothing but a few crackers to eat for more than thirty-six hours. They were the first to engage; were severely engaged, and as long as, or longer than, any others; they were badly cut up, losing their colonel and other officers, and sixteen per cent. of the ranks in killed. They stood firm under fire while the panic-stricken crowd swept by and through them, and until they received the order to retreat. They then wheeled steadily into column, and marched in good order, until the road was obstructed by overturned wagons. Here they were badly broken up by a cannonade, scattered and disorganized, but afterwards, having mainly collected at Centreville, reformed and marched the same night, under such of their officers as remained alive, to and through Washington to a position several miles to the northward—a post of danger—where they at once resumed regular camp duties. When visited by the inspector, a few days afterwards, he was told and was led to believe that the men had only wanted a day's rest to be ready and willing to advance again upon the enemy. He reported the regiment not demoralized.

The returns of the inspectors are not conclusive on this point; but from the result of subsequent specific inquiries by Mr. Elliott and the Secretary, it can be stated with confidence that indications of terror or great fear were seen in but a comparatively very small part of the retreating force. Most trudged along, blindly following (as men do in any mob) those before them, but with reluctance, and earnest and constant expressions of dissatisfaction and indignation, while no inconsiderable number retained, through all the length of the privation and discomfort of their dreary return to Washington, astonishing cheerfulness and good humor, and were often heard joking at their own misfortunes, and ridiculing the inefficiency of their officers. The Germans of the reserve were frequently singing. None of the reserves were in the slightest degree affected by the panic, and their general expression with reference to the retreat was one of wonder and curiosity.

The reserve, nevertheless, suffered much from fatigue, and subsequently exhibited most decided demoralization.

V.

AMBULANCE.

It is well known that the means of transportation which regiments of different States have brought to the seat of war with them, provided by the care and forethought, and paid for by the pecuniary liberality of the State or district supplying these troops, have, on their arrival at Washington, been withdrawn from them, and turned into the common stock. To the corps d'armée, whose position, in the front of operations, renders them liable to the various contingencies of war, a very limited supply of means of transportation for the sick and wounded has been provided, far less in many cases than their original property. Since this report was prepared, the first important skirmish in the army of the Potomac for some months has occurred. In all previous engagements it is notorious that the ambulance arrangements have proved, to the last degree, inadequate, and imperfect. Many lives were lost at Ball's Bluff, for instance, in consequence of this, and more would have been, had not a volunteer surgeon, without authority, compelled men to assist him in his duties, by drawing his revolver and shooting at the first who refused to obey his orders. Since then the Medical Director has issued orders, excellent in spirit, for the training of a small number of ambulance attendants in each regiment, and it was hoped that we might be spared renewed occasion of shame for neglect to care for wounded men. In the affair at Drainsville, December 20th, Ord's brigade took to the field its whole ambulance provision, consisting of nine covered spring carts, in which but eighteen men could well be carried at once. The engagement took place twelve miles from where a "division hospital"—an anomaly in the service, unprovided for in the Regulations or Supply Tables—had been permitted to be established. Some sixty suffering men were got back to this hospital. But, although we had in this case driven the enemy in confusion from the field, for lack of ambulances, we were obliged to leave all but three of his wounded, (thought to be larger in number than our own,) on the ground where they fell, at the beginning of a December night.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

VI.

VOLUNTEER ARMY SUPPLIES.

It is hardly just to let this report go forth to the public without a more distinct reference to the deep and earnest, resolute and abiding spirit of patriotism in the women of the country of which the Commission daily receives more tangible evidence than can be conveyed in words. From a backwoods neighborhood, for instance, comes a box containing contributions of bed clothing and wearing apparel from sixty women and children, the invoice running thus: "*One pair of stockings from the widow Barber; one quilt, two bottles currant wine, one cheese, Mrs. Barber; two pillow cases and one pair stockings, Jane Barber; one pair stockings and one handkerchief, Lucy Barber; one pair mittens and Robinson Crusoe, Jedediah Barber;*" and then follows the list of contributions of another family. A few devout words only are commonly added to such a list, but they imply that the donors are ready to give all they possess if it shall be needed to maintain the inheritance of our fathers. Blankets worn in the Revolution, and others taken in the last war with England, heir-loom linen, with great-grandmother's hand-marks, and many family treasures, are sent as free-will offerings, with simple prayers that they may contribute to the comfort of some defender of liberty. To the same end, the first ladies of the land, if any are entitled to that appellation, have, without cessation, during all the hot summer, been engaged daily in dry, hard, plodding work, sorting, marking, packing goods, and carrying on extended and tedious accounts and correspondence, with the precision, accuracy, and regularity of trained merchants. In all there is little character of romantic enthusiasm, but much, and, as the months pass, more and more, of deep-seated, abiding, self-sacrificing resolution. It seems as if the women were just now beginning to feel how much they love their country; and the inquiry "How can we best do something for the army?" is coming from every quarter, from the border slave States as well as the free. That it is important that this desire should be gratified, and with judicious economy directed where it will most truly aid, however slightly, the strength and comfort of our soldiers, there can be no question. Although our volunteers are, as compared with the soldiers of other armies, generously paid, few large armies of modern times have been as little influenced by mercenary motives. The gifts which, especially when sick and wounded, the men have sent to them from the women at home, can but have an ennobling influence upon them; and the aid given in this manner to the army, must create in all those from whom it proceeds, an interest in and sympathy with the army, and with its objects, which will prepare them constantly for greater sacrifices and more resolute devotion to the Government, should it be needed. How well Washington understood this, the following letter, written by his own hand at a time when he must have been overloaded with business of the grandest importance, gives evidence. It has never before been published:

Copy of a Letter from Gen. Washington to Mrs. Bache, (Daughter of Franklin.)

HEAD Q'RS IN BERGEN, N. J., *14th of July*, 1780.

MADAM: I have received with much pleasure—but not till last night—your favor of the 4th, specifying the amount of the subscriptions already collected for the use of the American soldiery.

This fresh mark of the patriotism of the Ladies entitles them to the highest applause of their country. It is impossible for the army not to feel a superior gratitude on such an instance of goodness. If I am happy in having the concurrence of the Ladies, I would propose the purchasing of coarse linen, to be made into shirts, with the whole amount of their subscription. A shirt extraordinary to the soldier will be of more service to him than any other thing that could be procured him; while it is not intended to, nor shall, exclude him from the usual supply which he draws from the public.

This appears to me to be the best mode for its application, provided it is approved of by the Ladies. I am happy to find you have been good enough to give us a claim on your endeavors to complete the execution of the design. An example so laudable will certainly be nurtured, and must be productive of a favorable issue in the bosoms of the fair, in the sister States.

Let me congratulate our benefactors on the arrival of the French fleet off the harbor of Newport on the afternoon of the 10th. It is this moment announced, but without any particulars, as an interchange of signals had only taken place.

I pray the Ladies of your family to receive, with my compliments, my liveliest thanks for the interest they take in my favor.

With the most perfect respect and esteem, I have the honor to be, madam,

Your obedient and humble servant,

GEO. WASHINGTON.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

BOROUGH OF LIVERPOOL.

REPORTS

OF

DR. PARKES AND DR. SANDERSON,

ON THE

SANITARY CONDITION OF LIVERPOOL.

ORDERED BY THE COUNCIL TO BE PRINTED.

LIVERPOOL:
PRINTED BY BENSON AND HOLME, 10, CASTLE STREET.

Table IV.—To show how much of the different Stations is Tropical; how much Extra-Tropical; and in which of these the

BOROUGH OF LIVERPOOL.

At a Meeting of the Council of the Borough of Liverpool holden by adjournment on Wednesday, 5th day of July, 1871

PRESENT:

JOSEPH GIBBONS LIVINGSTON, ESQ., Mayor,

AND A FULL COUNCIL.

Read letter from Dr. Parkes and Dr. Sanderson, enclosing the first portion of their Report on the Sanitary condition of Liverpool.

Resolved—

That the same be referred to the Health Committee and printed, and a copy sent to each Member of the Council.

Extracted from the minutes,

JOSEPH RAYNER,

Town Clerk.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

49, QUEEN ANNE STREET,
LONDON, JUNE, 1871.

THE TOWN CLERK OF LIVERPOOL.

SIR,

We have the honor to forward to you the first portion of our Report on the Sanitary Condition of Liverpool. We regret that there has been so much delay, but as you are aware we have been waiting for the Census Returns which are necessary to enable us to give a reliable opinion on the causes of the Mortality of Liverpool.

Although we hoped to obtain these returns in May, we have not received them and fear that it will be yet several weeks before they will reach us. We do not think it desirable therefore to delay longer sending you the instalment of our Report which relates to the two special points which we were asked to investigate, viz: the material used for filling up ground and the ventilation of the sewers.

With respect to this last point we think it right to state that the charges brought by Mr. Bennett against the Municipal Officers, even if true, do not in the least affect any of our facts and conclusions. But in justice to the Municipal Officers we think it our duty to express a decided opinion that Mr. Bennett has fallen into error in supposing that the manholes were opened some hours before we entered the Sewers for the purpose of misleading us.

The preparations for our inspection were made in accordance with our own instructions so that we were perfectly aware of their nature. For the delay which occurred between their completion and our visit we are entirely answerable.

We will forward the second portion of our Report with the least possible delay when we receive the data from the Census Office.

E. A. PARKES, M.D., F.R.S.
J. BURDON SANDERSON, M.D., F.R.S.

REPORT ON THE SANITARY CONDITION OF LIVERPOOL, BY E. A. PARKES, M.D., F.R.S., AND J. BURDON-SANDERSON, M.D., F.R.S.

INTRODUCTION.

In December last we undertook at the request of the Corporation of Liverpool to make an enquiry into the Sanitary Condition of the Town.

The nature and extent of the inquiry were defined in Resolutions of the Health Committee and Town Council, with Copies of which we were furnished.

In these Resolutions, the subjects to be investigated were stated in the following words and order :—

1.—The present practice of filling up with ashes, land intended to be built upon. (Resolution of Health Committee, November 24, 1870).

2.—The state of the Drains and Sewers especially with regard to their ventilation and of the privies, water closets and ashpits.

3.—The system of Scavenging now adopted. (Resolutions of the Council November 24, 1870).

We accordingly proceeded to Liverpool on the 1st March, 1871, and on the following day attended a special meeting of the Town Council. The Chairman of the Health Committee then read an address which clearly set forth the points on which our opinion was desired. This address is given in the foot note below as well as the Report of the Superintendent of Scavenging referred to in it.*

ADDRESS READ AT THE MEETING AT THE TOWN HALL, MARCH 2ND, BY DR. TAYLOR, CHAIRMAN OF THE HEALTH COMMITTEE.*

DRS. PARKES AND SANDERSON,

Gentlemen,

You who are practically acquainted with the many difficulties which are inseparably connected with the hygienic management of large towns, and with the total absence of any definite and fixed rules for such management, will not be surprised to know that various opinions have arisen in Liverpool as to the effect of the action of the Health Committee in reference :

1stly.—To the disposal of refuse and especially to that cinder refuse which is unpolluted with ordure and therefore useless as manure.

2ndly.—To the construction, ventilation, and trapping of the sewers of the town, and the injection into them of steam and water at a high temperature.

3rdly.—To the substitution of trough and syphon water closets in lieu of privies and cesspits.

It is therefore with a wish to satisfy public opinion on these three important questions that your scientific aid has been invited by the Council of the Borough.

I have received for your information from Mr. Reynolds, the Superintendent of Scavengers, a report on the mode of disposing of the refuse of the Town, and also a list and description of the pits, delfs, and brickfields which have been filled up in the mode mentioned in his

It was however desired by the Council that we should not confine ourselves to the points raised in the address, but should investigate the Sanitary Condition of

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report. Mr. Reynolds has the orders of the Health Committee to show you these places and to facilitate in every way your investigations.

The subject is, in an economical and rate-payers' point of view, one of the greatest importance to Liverpool and other towns of Lancashire which may adopt the water closet system of sewage ; since the disposal of valueless ashes is a difficulty very little less than the disposal and utilization of the sewage itself.

The Health Committee therefore desire to know whether there can arise, from their mode of removing and utilizing refuse, anything injurious to health ;—whether the levelling of brickfields and the filling up of ponds, in the manner described by Mr. Reynolds will produce any appreciable amount of gases injurious to health, either at the period of the deposit of the materials used or after their consolidation into a firm foundation for houses.

Your opinion is also requested on the wider subject of the influence of the foundation of houses on the health of the inhabitants.

Many years ago, before the establishment of a Health Committee or the existence of any sanitary statutes, the refuse of chemical manufactories was largely deposited in the pits and brickfields situate at the north of the Town. These fields are now a populous district, and not only are many of its houses built on chemical refuse but its sewers have been obliged to be constructed through large areas of such material. As a natural consequence the sulphide of calcium will, in spite of every precaution, find its way into the sewers. Hence the evolution of sulphuretted hydrogen, especially where the sulphide meets the acid refuse of manufactories. This has been a long felt evil frequently brought before the notice of the Health Committee by their officers. The Council will be very glad if you can suggest any practical mode of remedying or abating this evil.

The central or older parts of the Town have no deposits of chemical refuse. The hollows left by the removal of brick clay were utilized as cellars or underground habitations. This portion of the town, contains the chief seats of epidemic fever ; indeed the chief Typhus field of 1865, and the Cholera field of 1866, was all that portion of the town which stands on a subsoil of clay, being situate between the River and Scotland Road, along the course of the old Pool to the top of Whitechapel. The Council will be obliged if this part is also surveyed by you.

The Borough Engineer and the Medical Officer of Health have received the instructions of the Health Committee to co-operate with you in your investigations and the general public have been invited to give you every information in their power. The Council will also gladly place at your command all the necessary technical help required by you in the investigation of the sewers and the water closet system of the Town.

REPORT OF THE SUPERINTENDENT OF SCAVENGING.

The Superintendent begs to report that it is the rule in Liverpool to empty Dry Ashpits and remove the cinder refuse from houses supplied only with water closets during [the day, whilst the contents of privies or ashes impregnated with human ordure are removed during the night.

To this rule there are three exceptions :

1st.—Ashes from offices connected with dwellings situated near the Exchange or chief business thoroughfares are removed during the night because their removal in the day time would interfere with the convenience of business men.

2nd.—Ashes which although contained in a Dry Ashpit are found to be of an offensive character are treated as night soil and midden refuse and dealt with at night.

3rd.—The contents of all Court Ashpits, that is pits common to a number of separate dwellings are treated as night soil and also removed at night.

All night soil and the contents of Ashpits treated as night soil are carted to the Railway Siding or one or other of the Wharfs and from thence are at once, without being deposited within the Borough, conveyed to farmers or to Depôts in the Country.

The contents of Dry Ashpits and the ashes collected by the dust carts are taken in the day

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

the town generally, with a view of offering suggestions for lessening the exceedingly high death-rate which has prevailed for many years.

Full power was given to us to conduct the investigation as we thought best, and accordingly we determined to examine into every point for ourselves and to take nothing on hearsay.

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time and together with the sweepings of Macadamised roads are utilized for filling up disused Brick Fields, Quarries, &c. The operations of removing all the town refuse is superintended by the district scavenging Inspectors whose visits are sufficiently frequent to guard against any evasion of the Instructions issued by the Health Committee either by the negligence or perversity of the carter.

The road detritus used for filling up is taken from the outskirts of the Town and contains but a very small proportion of organic matter. The road scrapings obtained from the central thorougfares, the sweepings obtained from paved streets and the refuse collected by the Barrow Men from the streets in thickly populated districts contain a considerable amount of animal and vegetable matter and therefore possess some commercial value, they are disposed of from the Wharfs to Farmers.

It is found that there is seldom any perceptible amount of Bones in the Ashpits for they and other substances having a commercial value are removed (if thrown into the Ashpit) by gangs of Boys and Women who search these places for whatever things can be sold.

Appended is a list of the principal places on which Dry Ashes have been utilized for filling up since January 1867, at which time the removal of the Town refuse was undertaken by the staff of the Health Committee.

Locality.	Description of place filled up.	Approximate Estimate of Loads Deposited.
Parliament Fields,	A Pond of Stagnant Water very offensive,	4,000
Moss Bank, Grove Park,	A Brickfield only partly filled (the place alluded to by Dr. Stallard) Brickfields	1,700
Tunnel Road, in two places,	1st place also complained of by Dr. Stallard,	2,000
North Hill Street, in various places,	Brickfield and Pits of stagnant water	10,000
Minto Street,	The same,	5,000
Poplar Street,	Dangerous Quarry,	15,000
Whittle Street, in two places,	Brickfields,	3,000
Westminster Road,	Ditto,	2,000
Cobb Delph,	Quarry,	2,000
Site of Zoological Gardens and vicinity, many places,	Pits, Stagnant Water and uneven ground	16,000
Podge Bank, near Grove Park,	Ditto,	2,000
Sefton Park, many places,	Uneven ground,	6,000
Great Mersey Street,	Brickfields and raising the land,	3,500
Sandhills, vicinity of stables,	For raising land to requisite height for building	6,000

The following are the places now in process of being filled up :—

Phythian Road,	Brickfields.
St. Domingo Grove,	Dangerous Quarry.
Hackthorpe Street,	The same.
Westminster Road,	Brickfields,
Stanley Road,	The same.
North Hill Street,	The same.

We met in our enquiry with the most cordial assistance from every officer of the Corporation, and we desire to express our grateful thanks for the help so constantly and so cheerfully given to us.

SECTION I.

On the practice of filling up inequalities of ground with Cinder-refuse.

Liverpool is built for the most part on a bed of clay lying over red sandstone rock. The clay is very stiff and impermeable and has been largely removed for brick making. The inequalities thus arising, were formerly filled up with refuse derived from chemical works, and in other ways.

The pits produced by the excavation become usually half full of water and naturally receive the refuse of the neighbourhood. Dirty stagnant ponds or unsightly pits with refuse occupy several of the suburbs, and for the sake both of health and appearance, and for the utilization of the ground require to be filled up. The filling up is being done by builders refuse, by the rubbish got rid of by private persons, and by the cinder-refuse of the town.

It is quite clear that these inequalities of ground must be got rid of, and the question is how this may be best done without injury to health. The use of cinder-refuse is said by its advocates to have the advantages of giving a dry firm subsoil, in which all organic matters are gradually got rid of by slow decomposition, so that on sanitary grounds alone they advocate its employment. But the plan has, they allege, an immense collateral advantage; it enables the Town to get rid of its ashes and house refuse, and in this way to meet a difficulty which is every year becoming greater. In London the ashes and refuse from houses are disposed of with little difficulty; the cinders are used by brick makers, the other articles are sorted and find a market. In Liverpool where coal is cheap the cinders are unsaleable and useless. Since the introduction of water-closets, no excrement is mixed with them and they have therefore no agricultural value. They must be transported from the town at the expense of the town, and as the cost is already great any additional expense of carriage would increase a burden already felt to be very heavy.

On the other hand the use as foundation for houses of cinders supposed to be largely impregnated with animal and vegetable refuse, though not with excrement, is considered by some to be dangerous in a high degree to the public health, and it is supposed that the welfare of generations to come may be imperilled by a false economy which purchases present exemption from taxation by throwing the burden on future years.

It will be seen that the point is one of very great importance to Liverpool and merits the most careful study.

The source and nature of the material used for "filling up" may be learnt from the Report of the Superintendent of Scavenging. It consists first of the contents of such ashpits as are regarded by him as inoffensive, and secondly of the sweepings from the macadamised roads in the higher parts of the town.

We are assured that it contains no excrement except that which may be included in the road scrapings at the outskirts of the town. The contents of all Dust-bins which appear to be offensive, as well as the scrapings of the paved streets in the central parts of the town are removed at night by Canal.

We visited various places where the process of filling up is going on, and we collected from six places fair samples of the deposited refuse. We also saw the method of collecting and removing the ashpit collections as well as the plan of removing the midden refuse.

The first point was to see of what the cinder-refuse consists, and the second to determine the effect which a soil made of it would have on the health of the people living over it.

Composition of Cinder-refuse.

The samples collected were numbered in the order of their collection, but in the following list we have arranged them in the order of the date of deposit, placing the most recently deposited first.

In all cases the samples were fair specimens and were taken from 3 to 5 feet below the surface, except in the case of No. 1 which was taken from the surface.

DEPOSITS OF CINDER-REFUSE.

No.	Place whence taken.	Date of laying down.	Length of time the refuse had been laid down when taken.
1	Old Brickfield, Phythian Road	9th March, 1871.	One day.
2	Tunnel Road	October, 1870.	5 months.
3	Grove Park, Toxteth Park	September, 1870.	6 months.
4	Phythian Road	February, 1870.	12 months.
5	Site of Reservoir, Old Zoological Gardens	June, 1868.	32 months.
6	Zoological Gardens	February, 1868.	36 months.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

The deposits were found to consist of cinders varying from the size of a pea to that of a large nut or bean or sometimes larger; of smaller cinders which were however quite recognizable; of a powder composed in part though not altogether of cinders, and of other matters. They were therefore separated into these four classes and the following gives the percentage composition of each class.

Percentage of large and small cinders, powder and other matters.

No. of sample.	In 100 lbs.			
	Large Cinders.	Small Cinders.	Powder.	Other Matters.
1	60.71	10.71	17.85	10.71
2	50.00	10.00	30.00	10.00
3	41.66	20.83	29.16	8.34
4	30.30	15.15	48.48	6.06
5	20.47	8.82	67.64	2.94
6	58.27	10.48	25.64	5.59

The "other matters" consisted of the following substances: about 8 ounces of each sample being taken and all the "other substances" picked out.

Other matters of—

No. 1. Pieces of potato; peahusk; bits of wood; bits of straw; paper; blotting paper; bit of bone; textile fabric; some hair.

No. 2. Pieces of wood shaving; rotten straw; broken crockery; rotten potato parings; burnt bone; a few pieces of old rotten woollen cloth; pieces of egg shell; stone; pieces of rotten paper.

No. 3. Feathers; bits of paper; rotten straw; little bits of rotten stick; bits of rotten potato; potato paring; bits of shell; small piece of brick; pieces of glass.

No. 4.—Rotten straw, fish bone, rotten potato parings, broken egg shells, a stone, a few pieces of unburnt coal, some bits of charcoal, some soft little pultaceous matters, usually coated with cinder dust and without smell till crushed, but then very offensive.

No. 5.—Pieces of glass, small stones, rotten straw, rotten pieces of wood, a little bit of solder. No potato parings but some small dark lumps which are evidently of organic origin but are quite free from smell and though

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

otherwise resembling them differ in this point completely from the similar lumps in No. 4.

No. 6.—Pieces of egg shell; cockle shell; pieces of glass; a stone; rotten straw; piece of crockery; piece of slate; pin; two pieces of rotten wood; two pieces of decayed bone; rusty nail; a little bit of rotten woollen cloth.

The "other matters" included in no case excrement, but simply the substances which naturally form part of the dry refuse of houses. The examination made it quite clear that bits of potato and other vegetable matters gradually decomposed. Distinctly recognizable in No. 1, 2, & 3, where they were all coated with ash, in No. 4 the bits of potato had taken the form of soft pultaceous masses, inodorous till broken across but then highly offensive. In No. 5 the same masses existed but were inodorous, while in No. 6 no such masses were found. As they must have been present at first it may be concluded that they were entirely broken down.

Potato and other vegetable and probably animal matters become then first coated over with fine cinders and are soon made inodorous till crushed; after 13 months they lose their character but are still offensive; while after 2 years and 8 months they are farther changed and lose all odour. In 3 years potato and all vegetable matters of that kind, have entirely decayed away; straw, wood, cloth, &c., though very rotten had not entirely decayed in 3 years.

The sense of smell confirmed these conclusions. The smell of No. 1 was very offensive; of Nos. 2 and 3 the smell was much less, while Nos. 4, 5, and 6, were perfectly devoid of smell except that given off by rather moist cinders.

We conclude then that the process of decay of all the most easily destructible matters is completed in 3 years, how long the wood and woollen cloth would remain recognizable we cannot say, probably for many years.

So much for the "other matters." Of the 3 other classes the large and small cinders require no further examination.

The "powder" was a dark colored, rather moist substance; under the microscope it presented no marked character, it was evidently in part composed of fine ash and cinders, and in part of earth, there were no living animals or plants in any case.

When incinerated and all the carbon burnt off, the remainder consisted of a reddish earth containing large quantity of iron and evidently derived from road sweepings.

The following table shows the composition of the powder, in 100 parts; the solids, the water and the indestructible substances being given, the latter consisted of the ash of coal and mineral matters from the road sweepings.

COMPOSITION OF POWDER.

	In 100 lbs.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Solids.	74.8	62.9	82.	76.3	82.6	73.5
Water.	25.2	37.1	18.	23.7	17.4	26.5
Ash and mineral matter left on incineration.	37.8	52.	45.8	56.96	66.78	47.4

In order to determine the amount of the nitrogenous constituents of the powder the following plan was adopted. The total nitrogen was estimated by burning with soda-lime; the amounts of ammonia and nitric acid were also determined by washing 1 part of the powder in 100 parts of cold distilled water and then determining the amount of the ammonia by distillation with caustic soda and of nitric acid by the Schultze-Wanklyn process.

The following table gives the results.

Table to show the amount of ammonia and nitric acid and nitrogen as determined by burning with soda-lime.

No.	In 100 parts of the "Powder."		
	Ammonia.	Nitric Acid $\left(H\,N\,O_3\right)$	Nitrogen by burning with Soda Lime.
1	·00422	·1034	·852
2	·00164	·0275	·390
3	·00138	·0545	·497
4	·00512	·0411	·426
5	·00180	·0470	·177
6	·00160	·0285	·372

The object of these determinations was to see first whether the powder was largely contaminated with nitrogenous substances or their derivatives, and whether in process of time any amount of purification had taken place.

The analyses showed much organic impregnation, and also that ammonia and nitric acid were present in some though not in great amount.* They proved also that the refuse just laid down was much richer in all these substances than the deposits of older date, but there is no evidence of regularity of purification. For example No. 2 refuse which had been laid down 5 months had exactly the same composition as No. 6 which had been down 3 years.

Of course it is impossible to be certain that when laid down each powder had the same composition, and it is indeed almost impossible that they should have had. Therefore any experiments of this kind are liable to fallacy. Still looking to the amount of nitrogen of No. 1 and No. 5 and 6, it appears reasonable to conclude that a slow process of formation of ammonia and nitrites and nitrates did go on and that the latter were washed out by rain.

That some decomposition went on in the soil was also shown by thermometrical experiments. A thermometer inserted in the deposit at Grove Park, 5 feet from the surface, marked 16° Fahr. higher than a thermometer inserted in sand at the same depth. At Phythian Street the thermometer in the deposit marked 2½° more than in sand.

Whatever may be the nature of this slow decomposition it did not appear that it produced any sulphuretted hydrogen, or other gas, or disagreeable vapour detectible by smell. But doubtless effluvia of some kind would be produced.

Such then is the composition of the cinder-refuse. The greatest part is really cinder or earth and is quite innocuous, but there is some vegetable and animal matter, and organic road debris which gradually decays. And looking to the very small quantity of ammonia, nitric acid and nitrogen existing in Nos. 5 and 6, it may be concluded that as in the case of the potato about 2½ or 3 years suffices to produce a considerable purification of the soil.

With respect to the influence of this cinder-refuse on the health of persons inhabiting houses built on it, the evidence is very defective. The refuse has only lately been used and as it certainly does not produce any one special disease, it would be impossible without prolonged and careful comparison of the health

*Dr. Heisch was kind enough to determine the solids, water, and nitrogen in three samples and his results are:—

No.	In 100 parts.		
	Solids.	Water.	Nitrogen.
1	72·86	27·14	·696
4	75·38	24·62	·300
6	76·64	23·36	·450

of those living on it, and of classes of the same rank and occupation living on other soils to give an opinion. For such a comparison there are no materials, and we are obliged therefore to fall back on general principles. We can have no doubt, that from a soil formed of such cinder-refuse and gradually decomposing, some effluvia must be given out which would be likely to pass into houses placed on the soil, and therefore, that on the general principle of requiring and ensuring purity of air, such a soil is objectionable, at any rate when first laid down.

Accepting this view and looking to the analysis of the cinder-refuse we advise the Town Council to adopt certain rules, which if strictly carried out will obviate the objections raised to the cinder-refuse as foundations for houses.

1.—No excavation should be used for the reception of cinder-refuse unless it is efficiently drained. This appears to us to be of special importance in relation to the filling up of brickfields. It is well known that the whole of the surface of clay is never removed, and there is always sufficient to form an impermeable basin in which, in the absence of drainage, water constantly collects. We hold it to be of the greatest importance for the rapid decomposition of whatever offensive material may exist in the "cinder" that it should be able to become dry. The only way in which this can be promoted or secured is by efficient subsoil drainage.

2.—As the vegetable and animal matter contained in the cinder-refuse decays and disappears in about 3 years, and is virtually innocuous before that time we recommend that places filled up with cinder-refuse shall not be built upon for at least 2 years from the date of the last deposit.

3.—We are well aware of the difficulty of disposing of the road scrapings, but we would advise that inquiry should be made as to the practicability of getting rid of the scrapings in some other way in the place of mixing them with the cinder-refuse.

4.—We think that the scavenging department should have very strict rules with regard to the selection of material. Much greater care should be taken by the District Scavenging Inspectors than is the case at present, and the Superintendent should hold them responsible.

It should be inquired also whether some system of sorting could not be resorted to and the more offensive matters picked out. It might be possible to employ the paupers in the Workhouse for the purpose, or to authorize small payments to the persons who now make a living by raking over the cinders after deposit, for such vegetable and animal refuse as they can pick out. Of course any such sorting would have to be done under some kind of supervision.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

In leaving this subject we must remark that in some cases filling up of excavations is being carried on by private parties, and in some instances with materials more offensive than those employed by the Town Authorities. We think all deposits of this kind should be inspected by the proper Town Officers acting under the orders of the Health Officer, and that whenever the deposit is of such a nature as to be a nuisance injurious to health, as defined by the Nuisances Removal Act, proceedings should be taken before the Magistrates with a view to abatement.

SECTION II.

On the practice of filling up with Chemical Refuse land intended to be built upon.

Some portions of the Town are built on the refuse of the Chemical Manufactories (of carbonate of soda), which formerly was largely used for filling up. We obtained two samples, one from Townsend Street, and the other from Bentinck Street, at a depth of about 6 feet from the surface.

The refuse is the insoluble residue after the carbonate of soda has been dissolved out of the "black ash." It consists principally of lime and carbonate of lime, with some sulphide of calcium, coal and sand.

Sulphuretted hydrogen and carbonic acid are liberated by acids, but, in the two samples obtained by us, no disengagement of sulphuretted hydrogen takes place from the action of the atmosphere alone.

From the personal inquiries we made, it appeared to be clear that in some of the houses built on ground made of this refuse, the smell of sulphuretted hydrogen is distinctly perceived and is a source of great discomfort. On inquiry we found that the gas entered the houses from the sewers and did not pass up from the ground below, and this was confirmed by finding that the air in the ventilating sewer shafts contained a large quantity of sulphuretted hydrogen. From what has been said it is clear that the disengagement of this gas cannot be attributed to the mere action of air on the chemical refuse, but is only produced by contact with acid liquids. We believe, there is no reason to doubt, that such acid liquids do exist in the sewers between Vauxhall Road and the Mersey, and that these are derived mainly if not exclusively from certain chemical works in that neighbourhood.

The remedy is clearly to exclude from the sewers one or other of the two substances from the meeting of which the gas is evolved.

We gather from the statement of the Chairman of the Health Committee "that the sulphide of calcium, will, in spite of every precaution find its way into

the sewers," and if this be so, the only remedy will be to prohibit the passing of acid liquids into the sewers.

We recommend that exact information should be obtained into the source of the acid liquid, and that proper provision should be made for its discharge into the Mersey without entering the sewers.

As to the question whether the expense of providing such additional drainage ought to fall on the Town or on the manufacturers, the Corporation will, of course, be guided by the opinion of their legal advisers.

We understand that the use of chemical refuse for foundations and for filling up is at present prohibited. While advising the Corporation to persist in this prohibition, we are of opinion that in those parts of the town in which the houses are built on chemical refuse, the public health is not likely to be injuriously affected by the fact. For apart from the Sulphuretted Hydrogen there is nothing in the soil which can affect health; it is entirely mineral, and if any animal or vegetable matters should pass in they would be destroyed by the lime. And as the evolution of Sulphuretted Hydrogen only occurs under certain conditions, health will not be affected if those conditions can be avoided.

SECTION III.

On the Condition of the Sewers.

Before making any observations on the question submitted to us we think it necessary to state from what sources our information is derived.

Our own survey of the interior of the Liverpool Sewers was limited. The day after our arrival, we examined the plans of the sewers and received from Mr. Newlands explanations on all points relating to their construction and arrangement on which it seemed desirable that we should inform ourselves. We then selected several sewers for inspection and made arrangements for entering them in company with Mr. Evans the following day. We found however that of those selected we had only time to accomplish the examination of two, viz., those of Richmond Row and Duke Street. It will therefore be understood that the statements relating to the ventilation of the sewers and the existence of deposits in them are founded on information obtained by other modes of inquiry.

As regards the existence of deposits it is obvious, considering that Liverpool contains more than two hundred miles of sewers, that even if our inspection had been ten times as extensive as it was, we could have formed no opinion from personal observation. We therefore requested the Borough Engineer to be good enough to furnish us with a complete return of all those sewers known to be in a foul state. This document which we append to our Report will we trust form the basis of further inquiries.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

As regards ventilation our conclusions are formed partly on our own observations, partly on information communicated to us.

So far as relates to the actual movement and pressure of air in the sewers and to the working of the Archimedean Ventilators, we have depended exclusively on our own experiments; but we have been indebted to the Officers of the Corporation for complete information as to the construction of the inlets, the form, capacity, and inclination of the sewers, the manner in which the outlets pass under the docks, the arrangements adopted for preventing the ingress of tidal waters, and all other constructive details with which it was necessary that we should be conversant in order to judge correctly of their possible influence on the movement of air.

Throughout our investigations of the sewers we were much struck with the difficulty of access. In order to enter the sewers we inspected, it was necessary in each case that the ground should be previously opened in the middle of a street, in consequence of which, as the ground was open for some time, the traffic was seriously interfered with. As with such a system, efficient and frequent inspection seems impossible, we think that proper side entrances should be constructed in sufficient numbers to enable the men to enter the sewers without difficulty, as recommended more than twenty years ago by Mr. Newlands (Vide Report of the Health Committee, 1848, page 80.)

VENTILATION OF SEWERS.

Under this heading we propose to consider those appliances which have for their object to prevent the contamination of the air breathed by the inhabitants of a town with sewage emanations. The efficiency of these means must be judged of, first by a careful consideration of the purpose they are intended to answer, and secondly by the accurate observation of the results obtained by their use. The purpose has been already stated. For its accomplishment, the first requirement is that there should be no air-communication whatever between inhabited houses and sewers or drains; and the second, that the air contained in the sewers should be at all times so diluted with common air, that when, as must always be the case more or less, it escapes into the streets, it may be as little injurious as possible. We have therefore to consider with reference to each of these two requirements in how far it is satisfied by the arrangements actually in existence in the town of Liverpool.

We regard the prevention of the entrance of sewer air into houses as an object paramount to every other in importance; for it is a matter of general medical experience that even a fractional contamination of the air of a sleeping

room is almost certain to produce disease sooner or later; whereas we know that in many towns (as *e.g.* the Metropolis) the air of the streets is polluted to a very considerable extent without any apparent detriment to the public health.

There are two directions in which our efforts to keep this dangerous intruder out of our houses must be made. On the one hand the drains by which the solid and liquid refuse is discharged into the sewer should be so constructed as to be impervious to air; on the other the condition of the air in the sewer itself should be such that if apertures exist, the external air shall rather tend inwards than outwards,—rather to enter the sewer by them than to escape.

As regards the construction of house drains and of the modes of trapping them efficiently, we do not propose to occupy space. We have had the opportunity of examining the excellent house drains which have been constructed by your officers in the streets inhabited by the poorest classes, and shall again advert to them in the section of this report which relates to the sanitary condition of those streets.

But this is the place to notice that the house drains in many of the courts open into the cellars, and, as is well known, the traps are often in such bad condition from the improper treatment they receive from the inhabitants, that practically the house and sewer are in direct communication. This is a matter requiring instant attention, and we believe that the proper course would be to alter the plan *in toto*; to insist on all inlets being placed outside of the houses in such positions that they can be easily inspected and repaired. This would necessitate in some cases a change in the arrangement of the water supply. In the other parts of the town, where the houses are inhabited by persons in superior circumstances and beyond the reach of official inspection; we cannot doubt it often happens that in Liverpool as elsewhere, the traps are so defective that they afford no safeguard whatever against the evil they are intended to prevent, or that the drains themselves are constructed of porous materials and in an imperfect manner.

For this reason the first of the two requirements with which we started, viz:— the prevention of air communication between the houses and the sewers, is beyond the control of the local authority, whose efforts must therefore be *mainly directed to keeping those drains which are under their own management in such condition as to render the defects of private drains as little dangerous as possible.* Granting that defects (*i.e.* communications between houses and sewers) will often exist, any means of sewer ventilation employed will be useful in proportion to its efficiency as a means of promoting draught from the houses towards

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

the sewer. In some parts of Liverpool, especially in those parts which are inhabited by the poorest classes, it has been sought to accomplish this object by the erection of ventilating shafts. To the working of these ventilators, and to the question of their practical utility, we shall devote a special section; but for the present confine our attention to those streets where no ventilators exist.

In these streets all communications between the sewer and the atmosphere are ostensibly closed, for of the two kinds of tributaries by which the sewers receive their solid and liquid contents, viz:—house drains and gully drains, both are supposed to be trapped. As regards the former we have already given reasons for believing that the supposition differs widely from the reality; but with respect to the gully grates we have no doubt from the inquiries we have made, as well as from the inspection of the inlets in certain streets, that the proposed object is fully and efficiently carried out, and that the traps in question are really all that they profess to be.

If the state of occlusion which some persons seem to think desirable, were practically attainable, *i.e.* if it were possible to close all the apertures which exist between the interior of the sewers and the external air, the state of things which would result would be attended with the greatest danger. Sewer air would from time to time be driven into houses with a force which no ordinary trap would be able to resist. Fortunately however, sewers, from the porous nature of the material of which they are constructed, can never be regarded as air-tight receptacles, so that although the pressure of the air contained in them may be momentarily raised above that of the atmosphere, equilibrium is very quickly re-established. For this reason there is practically no danger of the entrance of sewer air into any house, of which the stoneware pipe service drain is properly constructed, and closed at the inlets with ordinary water traps in good order.

Special measures for ensuring the dilution of the air contained in the sewers are chiefly required in sewers which contain deposits. In those which are in good order, *i.e.* in sewers so constructed, that with a sufficient flow of water (by which we mean a supply amounting to not less than 30 gallons per day per inhabitant), the channel will remain perfectly free from solid deposits, there is we think no necessity for the employment of any special apparatus. It is well known that in the interior of any sewer which is in the condition we have supposed, the air is so little polluted that even persons who are not habituated to sewer-air may remain in it for hours without any present discomfort or subsequent injury, the reason being that the quantity of sewage is

small in proportion to that of the water with which it is diluted and covered. It can scarcely be supposed that all of the Liverpool sewers are in this satisfactory condition, so that although we are inclined to believe that Liverpool may be favorably compared in this respect with other towns and even with London, it is not the less necessary to consider the case of those streets in which the sewers are constantly foul, either because they are built in the antiquated form which was employed many years ago, or because their inclinations are insufficient. In all such cases we think that immediate measures ought to be taken to remedy the fundamental evil either by the construction of new sewers or by altering the levels; and that in those cases in which it is impossible, for engineering reasons, to avoid having sewers of deposit, the special means to be hereafter described should be adopted for ventilating them, *i.e.* for diluting the air contained in them with as large a portion of fresh air as possible.

Before proceeding to state the practical recommendations we are disposed to found on these considerations, we shall discuss some special questions which have been raised, and which bear more or less on the subject. These are

(1) The effect of the closure of the sewer outlets;

(2) The effect of the entrance into the sewers of large quantities of warm water from manufacturers;

(3) The effect of discharging steam and water at a very high temperature into the sewers and,

(4) The efficiency of the Archimedean ventilators.

I. Closure of the Outlets.

It is well known that most of the outlet sewers pass under passages of the Docks by means of syphons before discharging their contents into the river, that consequently although they allow of the free passage of liquids, they are at every state of the tide, effectually closed so far as relates to the passage of air, and that, excepting in extremely low tides, the mouths of the sewers are always under water. It has been supposed by some persons that this state of things instead of being advantageous is dangerous because it interferes with ventilation; it is imagined that a sewer through which there is not a thorough draught from end to end must be in a very unsatisfactory state, and that therefore effectual measures ought to be taken to provide for the remedy of so serious an evil.

Although on general principles we regard the apprehension which has been felt on this subject as absolutely groundless, it appeared to us necessary to satisfy ourselves by actual observation that neither the occlusion of the outlet nor the fluctuation of the tide exercise any influence whatever on the ventilation of the sewers. For this purpose we selected the sewer* which appeared to us more likely than any other to be affected by these causes, viz. that branch of the Gower street sewer which receives the drainage of the streets in the immediate neighbourhood of the Custom-house.

The reason why this sewer was selected will be apparent from the accompanying diagram in which it will be seen that the sewer and its tributaries form a system of themselves entirely unconnected with any others. In this sewer as elsewhere, the level at which the water stands varies with the state of the tide. At the man-hole in Canning Place, the point selected for observation, the sewer is quite full at high water, even when the tides are low. When as occurred at the time of our inspection the tides are unusually high, the water rises in the shaft to 2 or 3 feet above the crown of the sewer, so that it fills not only the sewer itself but all its tributaries. Here then is a sewer the ventilation of which if any must be certainly affected by the influx and efflux of the tidal water. The method we employed of testing it was simple but accurate. With the kind assistance of Mr. Evans we fixed above the shaft a water-manometer or gauge which was connected with the interior of the sewer by a vertical leaden pipe which passed down the shaft. The shaft having been carefully closed in such a manner that there was no other communication between the interior and exterior excepting through the leaden tube, a series of observations were made, which extended over 4 days as to the condition of the air contained in the sewer while the water was flowing and ebbing. The results were as follows.

On March 9th high water being at 1h. 3m. pm., the tension of the air in the sewer was shown by the gauge to differ very little from that of the atmosphere during the rise of the tide. *If anything it was rather less.* On the following day the two columns were level during the same period. On the 11th there were slight differences but these were not only inconsiderable in themselves but were evidently accidental, the pressure being sometimes greater outside, sometimes inside. During the period of ebb, the results were so similar to the above that it is scarcely worth while occupying space in stating the details. There was on the first day a slight tendency to in-draught at the beginning of the ebb but it was trifling and so temporary that it was evidently dependent on accidental circumstances. On each day the moment at which the water reached the crown of the sewer was indicated by the ejection of the water from the gauge; and this happened again and again during the height of the tide.

* See Plan of Canning Place Sewer in Appendix.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

The results of the experiment were precisely what might have been anticipated. In consequence of the innumerable channels permeable to air by which the interior of a sewer communicates with the exterior, and the relative slowness with which the tide rises and falls, the displacement of air during flow, and its replacement during ebb has no appreciable influence.

So far therefore as relates to ventilation, the closure of the outlets and the filling of certain of the sewers by the tide are matters which deserve no consideration.

2.—Discharge of Warm Water into the Sewers.

On the 26th of April one of us had the advantage of an interview with a Committee of the Liverpool Chamber of Commerce on this subject, in presence of your Chief Magistrate. The gentlemen who were present on that occasion, who represented many of the most important manufacturing firms in Liverpool, afforded us very valuable information with reference to the enormous extent to which the practice of discharging warm water into the sewers prevails. It appeared that without taking into account any other Manufactories excepting those whose representatives were actually present, no less than twenty-five million gallons enter the sewers weekly; of this quantity the greater part is water which has been used for the purpose of condensing steam and is discharged at a temperature which varies from 80° to 100° Fahr. The remainder is derived from the Sugar Factories and has been used for washing the animal charcoal after its employment for the decolorization of sugar. Thus water enters the sewers at a temperature of not less than 110° Fahr.

We were further informed that nearly the whole of this enormous quantity of water was derived, not from the water supply mains, but from private wells, whence the important fact is arrived at that in addition to the 10,000,000 gallons of water which daily pass down the sewers derived from the ordinary sources of water supply a relatively large quantity is conveyed by them derived from the Manufactories; so that the whole discharge if the accuracy of this statement is to be relied upon, amounts to fourteen millions daily or about 26 gallons per head per diem.

After our interview we availed ourselves of the opportunities which were obligingly offered to us of visiting the principal manufactories. The main purpose of our visit was to ascertain more precisely in what way the discharge of warm water is regulated, for it was apparent to us that, although under any

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

circumstances the practice could not fail to exercise a very material influence, the degree and nature of that influence would largely depend on the regularity or irregularity of the flow. An agency which is constant may, even if deleterious, be counteracted by suitable measures, but it is very difficult to provide against the ill effects or to avail oneself of the good effects of a cause of which the operation is occasional and irregular.

The general result of our enquiries on this head was that although in the smaller manufactories, condensation-water is discharged only during working hours and is often interrupted, in the larger works the flow takes place day and night. In every instance however there are some important irregularities. In addition to the stoppage of work which occurs on Sundays, there is even in the largest factories a considerable diminution in the rate of discharge during the night, so that on the whole we cannot regard the flow to be, even under the most favorable circumstances anything like uniform.

We think that there are two ways in which the practice in question may have an influence for good or evil on the health of the town. It may act either by producing and maintaining a high temperature in the sewers, and thereby materially accelerating putrefactive decomposition of their contents, or by altering the relation of barometic pressure between the interior and the external air.

With regard to the first of these points, it is not possible to speak decidedly. It does not however appear to us to admit of doubt that the putrefactive process will go on much more rapidly in a sewer which is irrigated with water at a temperature of 60° to 80° Fahr. than in a sewer of the temperature of the air; and further that the development of living beings of low organization will take place more rapidly and in greater abundance than under ordinary conditions; and we are disposed to believe that at all events in certain states of the external temperature they must exercise an important influence in the production of disease.

The second point is more immediately within reach of investigation. As a basis on which to form an opinion, we made observations on the ventilation of two sewers which appeared to us (after consulting with Mr. Evans) most likely to be affected by the discharge of warm water. We selected for the purpose the Beckwith Street Sewer* and the Sewer in Vauxhall Road, the

* See Plan of Beckwith Street and Pownall Square Sewers in Appendix.

former as being in immediate communication with the sewer which receives the discharge from the works of Messrs. Heap and Co., (1,000,000 gallons weekly) the latter as being indirectly affected by the numerous manufactories in the neighbourhood.

These observations were made on the same days as those we previously referred to in Canning Place and by the same method. From the results obtained in Beckwith Street we learnt that during certain hours of each day air was injected into the sewers by pulsations, which recurred at intervals of about 26 per minute. Of the quantity of air injected we could, by the mode of investigation employed, form no judgment, but we inferred that it was considerable from the fact that at each stroke the water column in the open limb of the manometer was jerked up to a height which varied from 2 to 5 tenths of an inch, instantly regaining its former level. On both of the days on which the observations were made it was found that the pulsations ceased about six o'clock in the evening, and that in consequence the state of ventilation of the sewer was materially altered. The pressure inside of the sewer which had previously been slightly in excess of that of the atmosphere, (about a tenth an of inch) was now in defect. The difference was very considerable, amounting on the 9th and 10th of March to nearly an inch. On the following day (Saturday) when notes were taken of the state of the gauges in our absence the readings were similar.

At our subsequent visit to Liverpool in April, we had the advantage of inspecting the works of Messrs. Heap & Co., under the guidance of one of the members of the firm, who was kind enough to give us the fullest explanations of their mode of working, so far as relates to the discharge of air and water into the sewers.

We learnt that in the sugar factory a powerful air pump is employed for the purpose of exhausting the vacuum pans, and, that the air discharged by this pump is conveyed along a large main into the sewer, and that its strokes are at the rate of about 26 per minute. We further learnt, as has already been stated that the discharge of warm water from the sugar and rice works although it varies in quantity per hour is always taking place, so that the sewers leading from the works are always flooded with water at a temperature varying from 100° Fahr. to the ordinary temperature according to their distance.

From these facts, taken in connection with our previous observations, we conclude that the general effect of the constant discharge of warm water into a sewer is to increase the in-draught, by diminishing the tension of the air in its

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

interior. When the air pump was at work this effect was neutralized, but whenever it was not working it was always found that a difference of pressure existed in favour of the atmosphere (*i. e.* the external air was drawn into the sewer) which on one occasion exceeded an inch and seldom fell below six-tenths, so that the effect of the warm water in increasing the in-draught appeared to be about twice as great as the antagonistic effect of the pump.

The observations on the Vauxhall Road Sewer were not calculated to give so direct an answer to our question as those in Beckwith Street, for the influence of manufactories on that sewer is comparatively indirect. The difference between the pressure of the air in the interior of the Vauxhall Road Sewer and that of the atmosphere was relatively very small. Twenty-three observations recorded during the 9th, 10th, 11th, and 12th of March, give an average of 0·1 inch in favor of the atmosphere, the greatest difference ever observed being 2½ tenths. Eight readings were in favor of the sewer, the remaining 15 in favor of the atmosphere, so that on the whole there was a preponderence of in-draught

These results are in our opinion entirely dependent on the large quantity of water which is discharged, and the rapidity of its flow; for it is well known that in all sewers in which there is a strong and rapid stream, a current of air is produced which is in the same direction as the water stream, and is *cœteris paribus* of proportional velocity. In a word, the in-draught at the inlets is due to the down-draught in the sewer.

We are therefore of opinion that the introduction of a large quantity of water into certain sewers which receive the drainage of manufactories, in addition to its obvious utility as a means of preventing deposit, may also be useful as regards ventilation, and that if the flow is constant, the ventilating effect will not be interfered with by the temperature at which the water is discharged. As before stated we think it not unreasonable to suppose that this benefit is likely to be overbalanced by the danger arising from the accelerated decomposition of the sewage, but in addition to this there is another ground of objection to the practice we are now considering, which although it has not yet been adverted to, is in the present state of the sewers in Liverpool of very great importance. We refer to the difficulty which the existence of warm water in the sewers puts in the way of frequent inspection. In consequence of the saturated condition of the air and the high temperature, no warm sewer can be entered unless it has been open to the air for some time previously; consequently no

such sewer can be inspected without the expenditure of much time and labor in the preliminary preparations.

3. Discharge of Hot Water and Steam into the Sewers.

On this subject we do not think it necessary to occupy much space. The "blowing off" boilers into the public sewers is so obviously improper, that we suppose that no one who has given the subject any attention will be prepared to defend it. When a boiler is "blown off" its contents enter the sewer at a temperature not much below the boiling point. Consequently the pressure on the interior of the sewer suddenly rises, and the air, aqueous vapour and gases it contains are forced out by the readiest outlet, *i.e.*, into the houses. We have the strongest ground for believing that the practice prevails pretty extensively, and do not hesitate to say that it ought to be prevented. For although in a sewer which communicates freely with the air, the effect of blowing off a single boiler must be of short duration, it can never be free from very serious objection. In the comparatively closed state of the Liverpool sewers the effect of the process must of course be much more serious.

4. The Archimedean Screw Ventilators.

We shall first show by experiment that the Archimedean Screw Ventilators really do the work which they profess to do, *i.e.*, that they actually remove a large quantity of air from the sewers. We shall then state the reasons which have led us to the opinion that notwithstanding their mechanical efficiency they exercise no practical influence in preventing the escape of sewer air into the streets and houses.

The Archimedean Screw Ventilators were examined on the 4th March, at the corner of Henry Edward and Fontenoy Streets, and on the 10th March in Townsend Street. In each case an anemometer was placed in the bottom of the shaft and the external opening was then closed. The experiments on the 4th March were less numerous than on the 10th and gave a considerably less movement of air. As our opinions is not favourable to the ventilating power of these shafts, and as therefore we wish to give the experiments which were most favourable to them, we do not think it necessary to give in detail those made on the 4th March.

The Townsend Street shaft has a height of 71 feet from the place where the anemometer was placed to the top; the wind was blowing rather gustily at 7 miles per hour, over the top of the shaft and at rather less rate in the street.

Ten observations were made with the screw working as usual, 10 with the screw stopped and 10 with the screw removed.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

TOWNSEND STREET SHAFT.

No.	Upward movement of air in feet per minute.		
	Screw acting as usual.	Screw stopped.	Screw removed.
1	410	412	268
2	549	354	437
3	417	417	427
4	379	361	323
5	466	365	420
6	601	426	403
7	473	318	299
8	461.5	347	288
9	433	405	353
10	437	365	254
Mean.	462.65	377	347.2
Miles per hour.	5.25	4.28	3.9

It is clear from these experiments that the screw has a real power and that stopping it reduced the movement just 20 per cent. When the screw was removed, it will be noticed that the rate was on four occasions much slower than in any case in the two first series. This was no doubt owing to the wind blowing not only over but into, the open mouth and thus checking the up current. The effect of the screw therefore is twofold; it really aids the up current, and it lessens also the chances of the wind blowing down the tube.

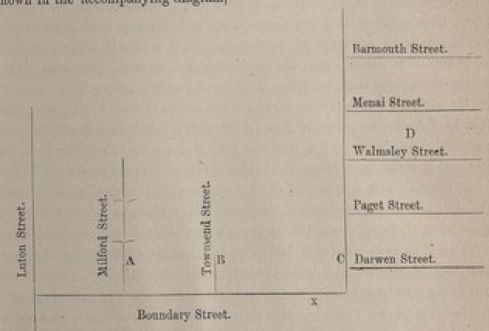
The height of the screw ventilator at the corner of Henry Edward and Fontenoy Streets was scarcely one-half of that in Townsend Street and the movement was considerably less, being in the former case 121, and in the latter case only 147 feet per minute, or at the rate of 1·37 and 1·67 miles per hour.

In all cases the section-area at the point where the anemometer was placed was 50 square inches (=·347 square foot). At the linear rate of 88 feet per minute or one mile per hour the discharge would be 1,832 cubic feet in an hour. The Townsend Street shaft therefore discharged per hour (1,832 × 5·25) 9,618 cubic feet, and this will represent we believe the most favorable result of the ventilators. On the plan of Townsend Street appended to the Report there appear to be about 7,000 linear feet of sewer with 4 ventilators. Supposing that the section-area of the sewers is 7 square feet, the total air contents of the sewers would be 49,000 cubic feet, so that the air would be changed once in

every 77 minutes by the action of the 4 ventilators. But this is doubtless placing the facts in far too favorable light for the ventilators, as one might be drawing against another: and the great height and position of the Townsend Street shaft renders it likely that we had chosen one of the most efficient outlets. It would have required simultaneous and numerous determinations of all the shafts to permit us to use this method of reasoning, and we prefer to put the facts in another way.

It appears that the ventilators regarded as mechanical contrivances are successful, *i.e.*, that the quantity of air which they discharge per hour is large as compared with their sectional area. But to judge of their practical utility we have to consider not the rate of movement in the ventilators themselves, but their efficiency in producing movement in the sewers with which they communicate. The most important points for inquiry are first whether the quantity of air discharged by them is sufficient for the required purpose, and secondly whether if it be admitted to be sufficient, the ventilators are so placed as to act in combination with each other or the contrary. It will be convenient to consider the second point first.

In illustration of the mutual action of the two existing ventilators on each other we may take as an example the system of sewers with reference to which the experiments above recorded were made. The sewer in Townsend Street, as shown in the accompanying diagram,—



N.B.—For a more accurate view of the relations of these sewers, see the Plan in the appendix.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

is a tributary of the larger sewer in Boundary Street. Above Townsend Street the Boundary Street sewer receives branches from Menai Street, Walmsley Street, Paget Street, and Darwen Street. Below Townsend Street it receives two tributaries viz.: from the upper half of Milford Street and from Luton Street. Connected with the sewers mentioned there are 4 ventilators viz.: one in Milford Street, one in Townsend Street, one opposite Darwen Street, and one in a Court leading into Walmsley Street. As has been already noticed an air current usually exists in a sewer in the same direction as the stream. Granting this, it is easy to show that the effect of the ventilators placed as they are, would be on the whole unfavorable; for their draught would be opposed to that of the air current already existing, and would therefore tend to diminish it. In the case of there being no previously existing current, *i.e.* no movement of air due to accidental causes, the action of the ventilators would be equally unfavorable; for if the ventilators A. B. C. D. act equally, it is clear that at all intermediate points they must neutralize each other's influence. Thus, for example, at the point (x) there must be stagnation, for whatever movement would otherwise be produced by A. and B. would be neutralized by C. and D. So also between A. and B. and between C. and D. respectively there must be points at which the effects are similarly balanced.

It is not however necessary to carry this kind of reasoning further, for even if the arrangement of the ventilators were most favorable, and their action perfect, their influence on the movement of air in the sewers must be so trifling as to be practically unworthy of consideration. The reason of this is that their size is out of proportion with the work they are supposed to perform. The internal diameter of each ventilator is under 8 inches. Hence if we assume that the available sectional area of most of the sewers is equal to that of a circle 3 feet in diameter, we have (the areas of two circles being to each other as the squares of their diameters) the sectional area of the sewer about 20 times as great as that of the ventilators. Consequently if we suppose such a ventilator to communicate with a sewer in which there would otherwise be no current, it would (theoretically) produce a current in either direction of one-fortieth of the velocity of its own current, so that if we assume the ascent of air in a ventilator to be at the rate of 10 miles an hour, an assumption which we need scarcely say is extreme, the utmost resulting movement in the sewer of air towards the ventilator in either direction, would be a quarter of a mile per hour.*

* Since the above was written we have received the exact measurement of the sewer in Boundary Street. The sectional area is 18.15 square feet, consequently that of the ventilator being one-fifth of a square foot the former is 90 times as great as the latter. So that a movement of 10 miles per hour in the ventilator would produce a movement of only one-eighteenth of a mile in the sewer.

Practically the movement would be so small that excepting in the immediate neighbourhood of the outlet, it could not be measured by the most delicate instrument.

We now return to the practical recommendations which follow from these considerations, but as none of the suggestions relating to the management and ventilation of the sewers, which we desire to submit to you could be carried out without additional detailed information, we think it desirable that in the first instance the whole subject be referred to your own Officers and therefore propose to submit to you certain heads of inquiry which may serve as instructions for the preparation of a detailed report.

The subjects on which it appears to us necessary to obtain more complete information in order to efficient action are the following:—

(1) The state of the sewers as regards deposits.

(2) The arrangements which should be made for the safe discharge of the steam from Engine boilers.

(3) The mode of remedying the existing defect of water for flushing.

(4) The escape of sewer air into the streets and houses.

With reference to each of these headings we shall indicate the measures which we think most necessary, leaving the way in which they are to be carried out to be determined according to the advice of your own Officers.

1.—The first subject of inquiry should be the present state of the sewers as regards deposits of sewage, the depth and nature of such deposits, the causes to which, in the opinion of the Borough Engineer they are due, and the works which are necessary for their prevention and removal.

In all cases we recommend that these necessary works shall be immediately commenced.

The "list of sewers shewing the depth and extent of deposit" appended to this report will serve to indicate the direction in which this inquiry must be made.

2.—The second section of the proposed Report should relate to steam-engine boilers communicating with the public sewers, and the works which are necessary (if any) in order to provide for the safe discharge of their contents. For this purpose an inspection must be made under the direction of the Borough Engineer, of all manufactories in which steam engines are believed to be employed, for the purpose of ascertaining in what way the periodical emptying of the boilers is effected. In all cases in which the boilers are fixed at such a level that they cannot be emptied otherwise than with the aid of steam pressure, or in which, on other grounds, there is reason to believe that the contents of the boilers are discharged

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

in a temperature approaching the boiling point, into any sewer, we think that the owners of such boilers ought to be required to provide a tank or cooling reservoir for the reception of the hot water during the process, in which it could be retained long enough to allow of its becoming sufficiently cool, and that in all other cases in which there is reason to believe that the contents of the boilers are discharged at an improper temperature, the practice be put a stop to.

We are not aware to what extent the powers vested in the Corporation for the regulation of the sewers may be sufficient for the enforcement of these or other similar measures, but we regard the matter as of such serious moment that, if existing legislation is inadequate, efforts should be made for its amendment.

3.—Your Engineer has repeatedly in his able reports called attention to the deficiency of the existing water supply for the purposes of surface cleansing and sewer flushing. In his Report of 1848 he recommended a plan for the expeditious flushing of all the main sewers, and at the same time pointed out that in addition to this, the means should exist of "washing impurities from the surfaces of streets and courts. For this purpose every court should have a branch with a stand pipe at its upper end for the washing of it daily. Every street should also have stand pipes at such distances apart that its whole surface may be washed over with the aid of a short hose. From these stand pipes also the streets should be watered" (p. 97.) In his evidence before the mortality sub-committee he further stated:—"Some time ago the Water Engineer and myself contemplated the introduction of the Parisian system of Bornes-fontaines, which are somewhat like our stand pipes erected at intervals along the streets, courts, lanes and alleys. From these the water is allowed to run freely along the channels for a certain time every day and wash away all impurities." But adds Mr. Newlands "our water supply has never been in a condition to admit of this." "The deficient water supply has thrown us back after 18 years to much the same condition in which we were in 1848, with the difference of extended works, and increased wants."

With all that Mr. Newlands has said as to the necessity of increased supply of water, we entirely agree and believe that it would be of the greatest advantage to the town of Liverpool if such a plan of surface irrigation as has been so repeatedly recommended by him could be carried out.

It is clear from the evidence, that the only obstacle which stands in the way of this desirable result is the want of water. It appears to us that this difficulty might be partly met by utilizing for the purpose the condensation-water from the manufactories. According to the statements which have been made

to us the discharge of such water, amounts to nearly 4 Million Gallons daily from only a portion of the manufactories. The whole of this enormous quantity is pumped every day to the surface by steam engines and is at present in great measure wasted, being discharged by each manufacturer into whatever sewer happens to receive the drainage of his works. This water is for the most part perfectly clean and fit in every respect for the purpose of surface cleansing. That there are no serious Engineering difficulties in the way of its being made available for irrigation in all the lower parts of the town, *i.e.*, wherever there happens to be a discharge at a higher level than that at the surface, we think admits of no question, nor do we think it probable that the Corporation would find any difficulty in arranging with the manufacturers for the disposal of a commodity which is so entirely of the nature of a waste product.

There are two considerations which encourage us in earnestly recommending this proposal to the attention of the Corporation. The first is the one we have already dwelt upon,—the expediency of obtaining a more abundant supply of water for surface as well as for sewer flushing. The second which is not so obvious is perhaps no less important. We refer to the unknown danger arising from mixing with sewage, water at the temperature which is known to be most favorable to putrefactive change. We cannot take upon ourselves to say how great that danger may be, for there are no data on] which it can be estimated. In any case the scheme we submit, seems to us to offer a way of escaping from it, as well as from all the other inconveniences which arise from the practice in question, while it retains all the good arising from this water entering the sewer.

On this subject it will be necessary that you should have a full report from your Engineer, as to the accuracy of the statements we have referred to regarding the quantity of water available,—as to the sewers into which it is at present discharged, and as to the constructive works which would be required in order to make it available for the purpose.

4.—In the fourth section it should be shewn in what localities, sewer-air habitually escapes from the outlets into the streets and houses in such quantities as to be offensive; to what circumstances such escape is attributable, and what measures ought to be adopted for the remedy of the evil. From observation we are led to believe that offensive discharges of sewer-air are mostly to be attributed to deposits in the sewers, and that if a sewer is properly constructed and has a sufficient inclination and a sufficient flow of water, the air escaping from it will not be seriously objectionable. We are however well aware that there are some cases in which, in consequence of accidental peculiarities of construction, discharges of sewer-air may constitute a nuisance notwithstanding

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the

that the sewers themselves are in good order. In all cases in which there are offensive discharges, we think that the expediency of adopting special measures of ventilation ought to be discussed. But before any such measures are actually taken, careful observations should always be made extending over a sufficient period for the purpose of ascertaining :

(1) Whether the supposed escape is frequent or merely accidental, and

(2) Whether it is of such a nature as to be capable of remedy by ventilation.

As means of ventilation we recommend the erection of large vertical shafts, the sectional area of which must be at least half as great as that of the sewers. The form and construction of these shafts must be determined by special circumstances. We content ourselves with observing that they should be as high as possible and that in every case their apertures should be at a sufficient distance from houses.*

We believe that, when the matter is investigated by the Engineer, the cases in which these special appliances for ventilation are required will be found not to be numerous, and on this account we recommend that whatever sum of money is destined for the purpose should be rather expended in erecting large and efficient shafts where they are urgently needed, than in the construction of a multitude of ventilators similar in size to those which at present exist.

We would not propose however to alter the shafts which at present exist, but simply to supplement them at certain points by others which we believe will be more efficient.

We think it desirable to sum up our recommendations on the question of the sewerage in a few sentences.

1.—We recommend that a complete and exhaustive inquiry be made as to the existence of deposits in the sewers, and that in all cases in which such deposits are in the opinion of the Borough Engineer dependent on defective construction, defective inclination or insufficient supply of water, the works necessary for the remedy of these defects be immediately commenced.

2.—In those cases in which the foul condition of the sewers appears to be unavoidable, *e.g.* in those sewers which are affected by the tide, we recommend ventilation. For this purpose we think that spacious and lofty shafts, afford the only effective means.

3.—We advise that in courts and in streets adjacent to them, there shall be no inlets to the drains within the houses.

* The employment of charcoal trays in these shafts may be a matter for after consideration.

4.—We do not recommend the adoption of any general system of ventilation, as we believe that the measures we have indicated will accomplish all that is necessary.

5.—We recommend that a complete report be made as to the quantity of waste water discharged into the sewers by manufacturers with a view first to the prevention of its introduction into the sewers in a warm state ; and, secondly, to its being if possible utilized for surface cleansing and sewer flushing.

In concluding this section of our Report, we beg to express our conviction hat it is not desirable to make any change in the present system of removing excreta. We do not wish to express any abstract opinion as to the respective merits of the water or dry method of removing fœcal matter, but looking to the circumstances under which Liverpool is placed we have no difficulty in coming to the conviction above stated for these reasons.

1.—Liverpool is well provided with sewers, many of which have been constructed with great care and cost.

2.—Structural defects or imperfection in action, in certain cases, can we believe be remedied.

3.—There is less difficulty than in many towns, in getting rid of the sewage.

4.—No other plan if now introduced could prevent the use of water-closets in a large portion of the town, and consequently excreta could not be kept out of the sewers.

5.—As no complete plan of dealing with the sewage of towns as large as Liverpool, has passed beyond the stage of experiment except the water sewerage system, we could not advise the Corporation to abandon or even modify a system in full operation, in unison with the habits of the majority of the population, and for which no substitute whose success could be guaranteed, can be pointed out.

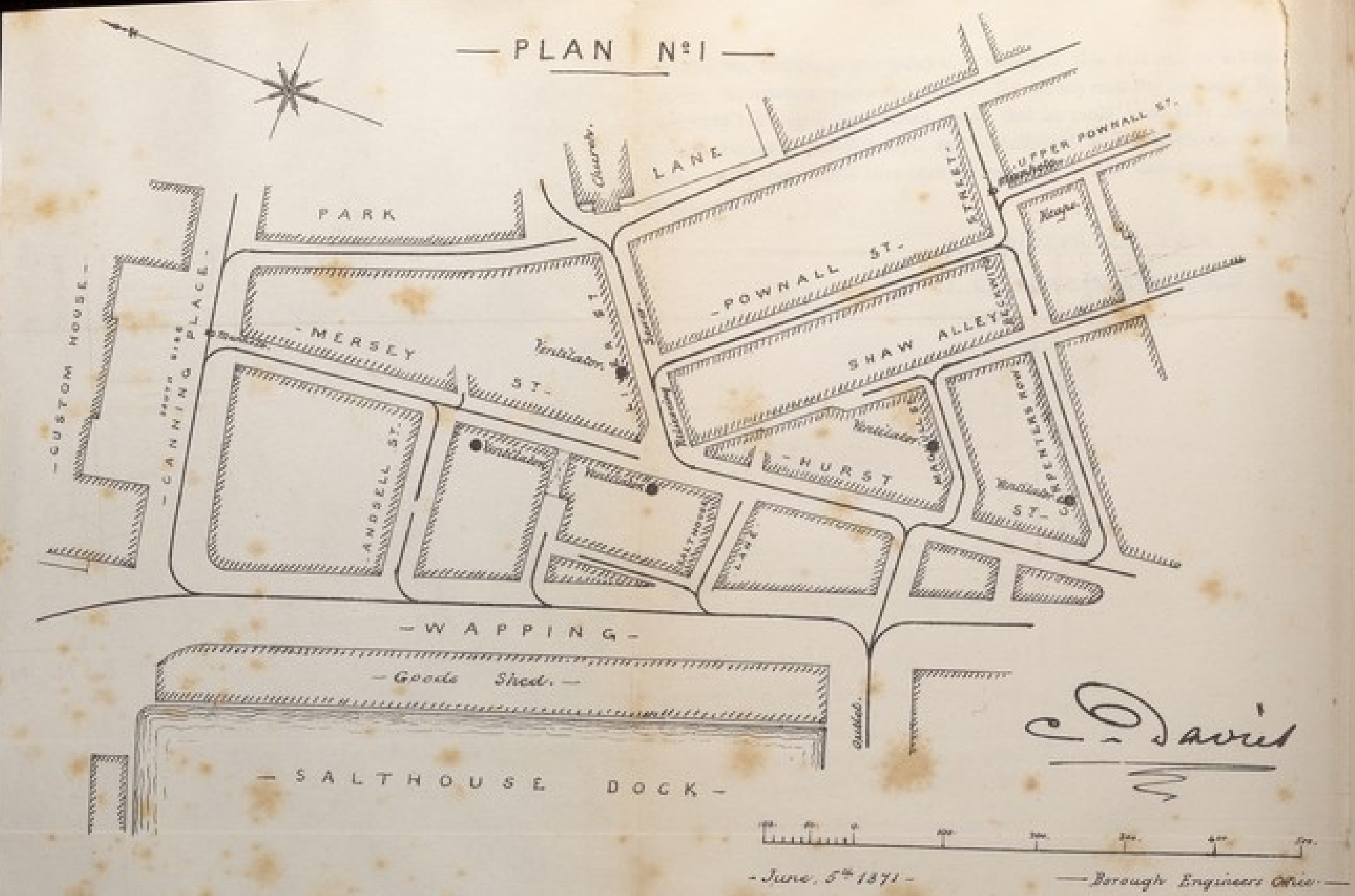
It would be useless for us to enter into an argument against a return to the barbarous system of middens, and needless to point out the difficulties of transport and disposal, which hamper all plans which aim at the daily removal of the excreta of great cities, otherwise than by water carriage. For even if such difficulties were overcome and if the excreta were removed as expeditiously as by the water method, which is impossible, a plan would be of little use unless it could be applied to the town as a whole.

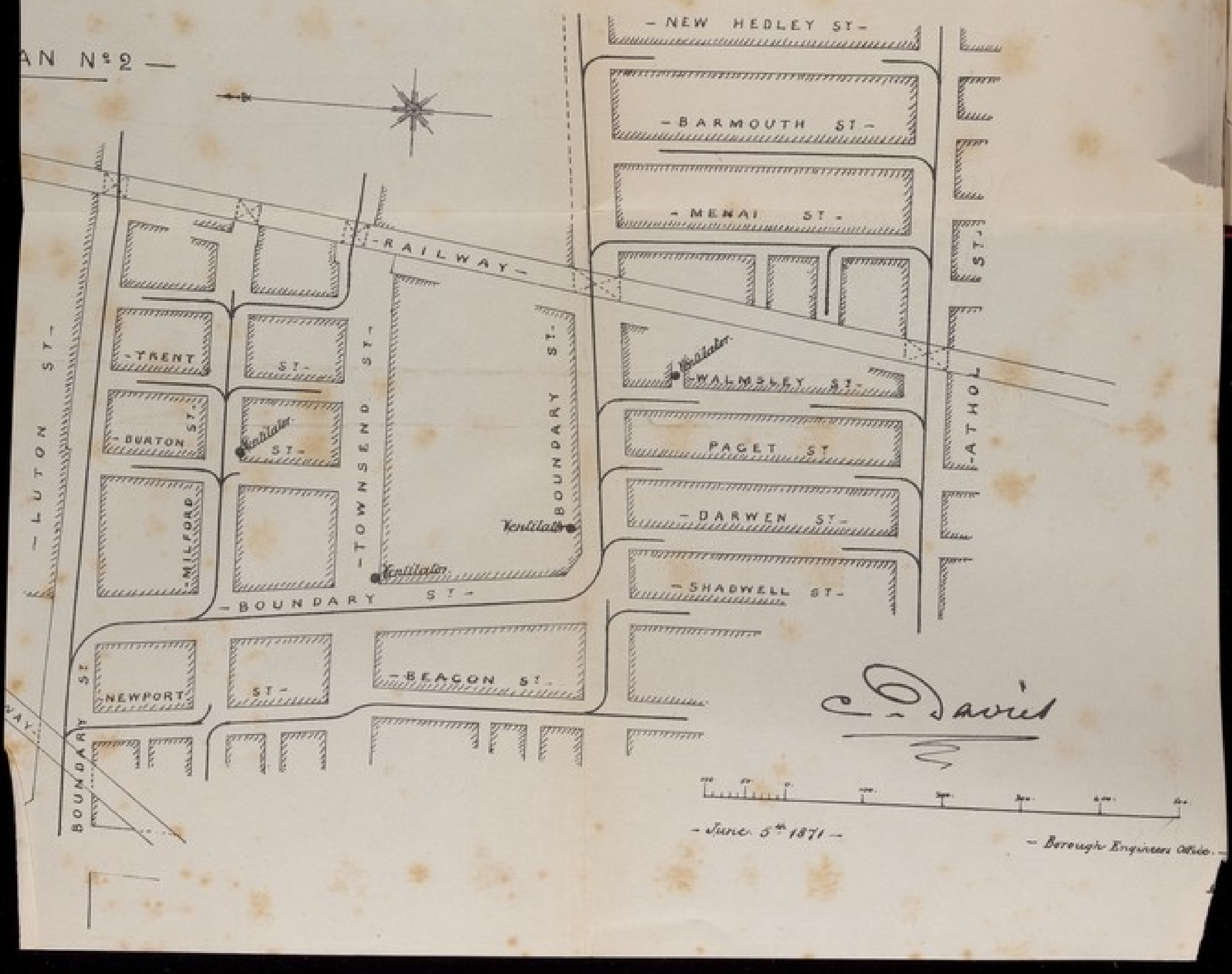
On this point we believe the time for argument has gone by; the system of water sewerage has been so thoroughly established in Liverpool, that it cannot be given up, and the proper policy is to recognize this fact and to act on it by making the sewers as perfect as possible. No one can read Mr. Newlands' Reports and study his suggestions without seeing that he could soon have removed all possible causes of dissatisfaction, and we believe if all Mr. Newlands' plans had been carried there would have been no necessity for the improvements we have suggested.

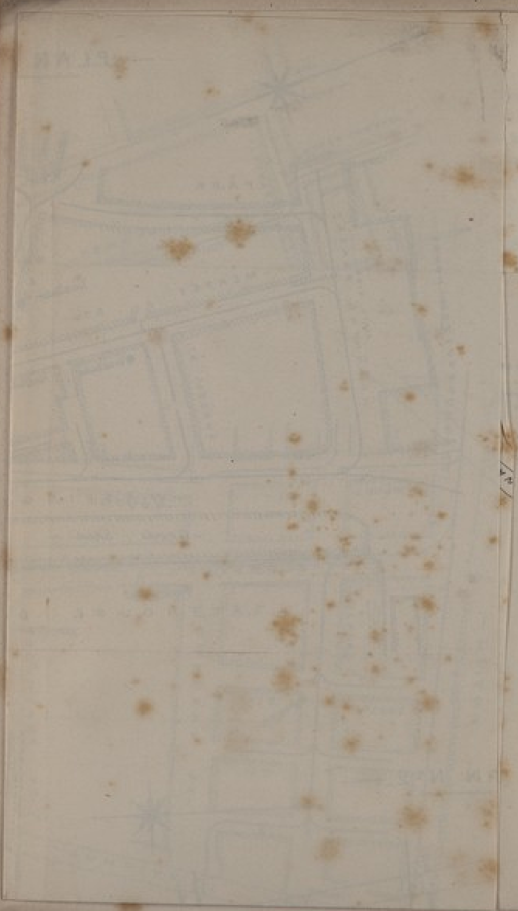
E. A. PARKES, M.D., F.R.S.

J. BURDON-SANDERSON, M.D., F.R.S.

TABLE IV.—To show how much of the different STATIONS is TROPICAL; how much EXTRA-TROPICAL; and in which of these the


PLAN No. 1
PARK
LANE
POWNALL ST.
UPPER POWNALL ST.
SHAW ALLEY
MERSEY ST.
HURST ST.
CARPENTERS ROW
CUSTOM HOUSE
CANNING PLACE
ANDSELL ST.
WAPPING
Goods Shed.
SALTHOUSE DOCK
Church
Outlet
C. Davies
June, 5th 1871
Borough Engineers Office


PLAN No. 2
NEW HEDLEY ST.
BARMOUTH ST.
MENAI ST.
RAILWAY
WALMSLEY ST.
PAGET ST.
DARWEN ST.
SHADWELL ST.
ATHOL ST.
TRENT ST.
BURTON ST.
MILFORD ST.
TOWNSEND ST.
BOUNDARY ST.
LUTON ST.
BEACON ST.
NEWPORT ST.
Ventilator
C. Davies
June 5th 1871
Borough Engineers Office



APPENDIX.

CONTENTS.

DESCRIPTION OF TRACINGS.

1.—A tracing of Canning Place Sewer showing that the System of Drainage formed by that Sewer into its two tributaries does not communicate with any other. In such a Sewer the supposed effect of the tide in driving the air upwards from the outlets towards the inlets would be much greater than in a system of greater extent. On the same street is shown the course of the Pownall Street Sewer, into which water and air are discharged from the works of Messrs. Heap & Co.

2.—Plan of the Boundary Street Sewer showing the osition of the Ventilators.

LIST OF SEWERS

SHOWING EXTENT AND DEPTH OF DEPOSIT.

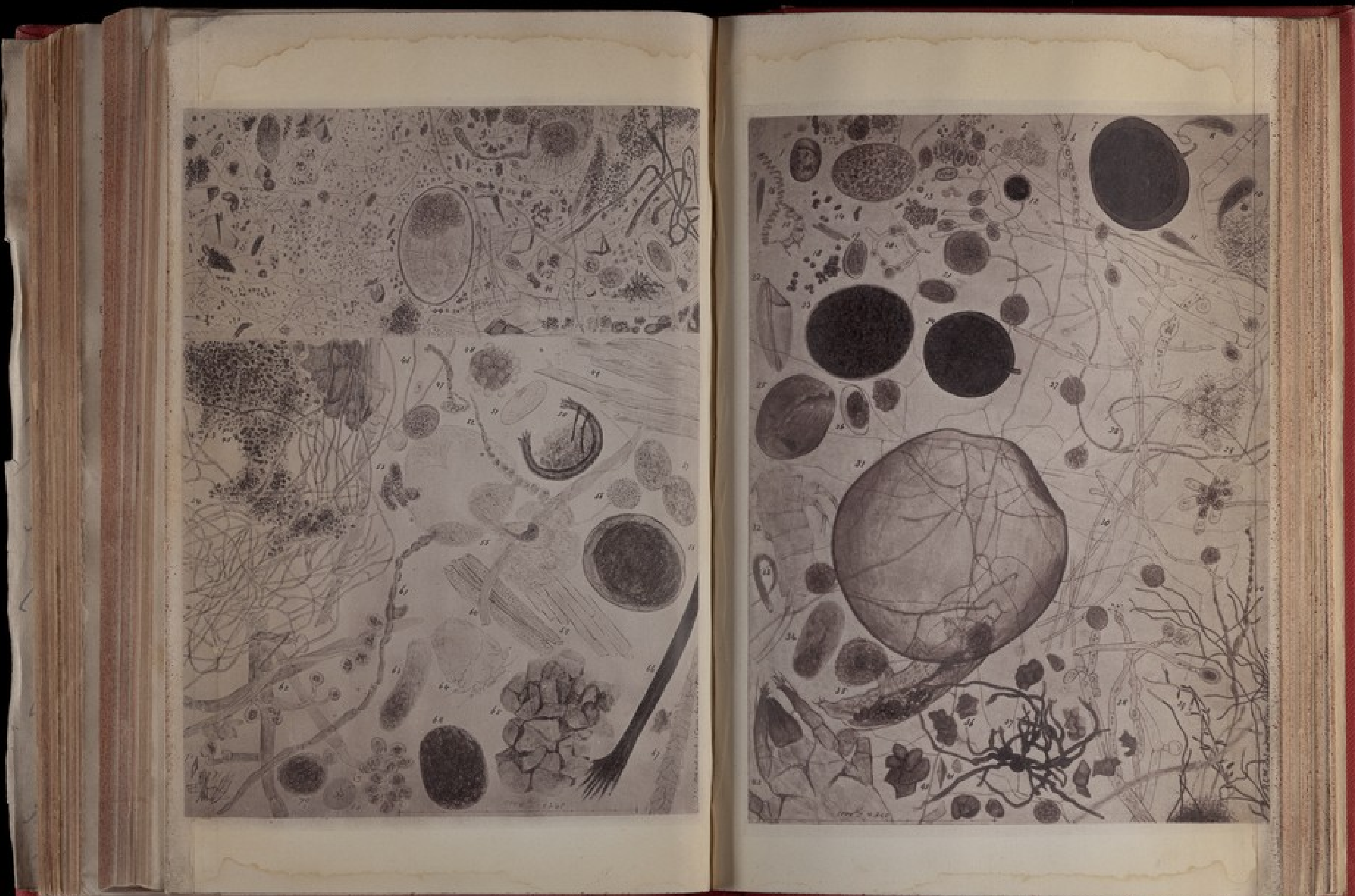
Names of Streets.	Length in Yards.	Depth of Silt in Inches.	Remarks.
Charters Street,	200	6	Old Sewer very flat.
Edgar ,,	112	2	
Cherry Lane,	215	2	
Back Chisenhale Street,	100	7	Old Sewer very flat.
Collingwood ,,	140	4	Very flat in hollow of Street.
Hodgson ,,	146	9	Old Sewer ,, ,,
Leeds ,,	350	6	
Midghall ,,	195	4	
Addison ,,	110	4	
Clement ,,	213	3	
Bow ,,	72	8	
Down ,,	132	4	
Nash Grove,	181	3	
Vauxhall Road,	500	6	Old Sewer very little fall.
Birkett Street,	107	4	
Dublin ,,	205	6	
Oriel ,,	207	6	
St. Martin ,,	125	5	
Harrison ,,	82	3	
Back Milton ,,	76	5	
Maguire ,,	198	1	
Ryley's Gardens,	55	8	
Duckenfield Street,	201	4	
St. Andrew ,,	233	3	
Troubridge ,,	190	7	
Manesty Lane,	229	12	All under High Water
Argyle Street,	140	4	with very little fall.

Names of Streets.	Length in Yards.	Depth of Silt in Inches.	Remarks.
Price Street,	72	6	
Frederick Street,	135	5	
Cleveland Square,	30	4	
Park Lane,	50	6	
Canning Place,	600	7	
Mersey Street,	189	8	
Queen's Dock, East Side,	319	4	
Cooper's Row,	91	5	
Redcross Street,	50	4	All under High Water with very little fall.
Carpenter's Row,	87	5	
King Street,	72	7	
College Lane,	120	6	
Atherton Street,	152	5	
Finney Lane,	34	8	
Cable Street,	55	5	
Paradise ,,	351	8	
Whitechapel,	455	5	
Church Lane,	88	4	
Williamson Street,	144	2	
Mann ,,	150	6	
Hyslop ,,	205	3	
Clive ,,	116	4	
Southwell ,,	55	3	
Jackson ,,	91	3	
Head ,,	181	3	
Low Wood ,,	238	3	
Oliver ,,	232	3	
Holden ,,	191	3	
Richmond Row,	40	9	Old Sewer very little fall at Byrom Street.

Fontenoy Street, at the corner of Henry Edward Street :—

Sectional area of Sewer, old Sewer	7,069 supl. feet.
Ditto ditto new Sewer	4,970 ,,
In Court No. 1, Hodgson Street	0,442 ,,
Branch at Townsend Street	5,151 ,,

Note.—This branch is connected with the Beacons Gutter or Boundary Street outlet, the sectional area of which is 18,154 superficial feet.



APPENDIX.

Note on the " Sewer Slime" obtained from the roof of the sewer in Richmond Row.

We give in an appendix two photographs of drawings of the objects found in the "sewer slime" which was taken from the crown of the sewer in Richmond Row. We have also given a few chemical points connected with this slime. These observations are of no immediate practical use, that is to say we are unable at present to connect any disease with the special growths in the sewer slime, but as there is a possibility that the progress of inquiry may give significance to some of these objects we have attached the drawings.

The sewer slime is a jelly-like substance composed of a mixture of dark coloured and greyish material. It is very alkaline from ammonia and contains nitrates. In the sample from Liverpool the ammonia obtained by distilation with caustic soda amounted to ·0025 per cent.; the so-termed "albuminoid ammonia" determined by Wanklyn's method was ·00462 per cent. and the amount of nitric acid was ·235 per cent. Offensive volatile substances were given off.

On microscopic examination it was found to consist of an immense amount of fungoid growth mixed with different kinds of animal life. The annexed photographs of drawings made by Dr. Maddox may be of interest in showing what is contained in the sewer slime; it has not been possible to name all the objects, but they have been all numbered for the purpose of future identification. For this we have also to thank Dr. Maddox. The figures were magnified 240 diameters, but the size of the plates has been reduced in photographing from 8 × 6 to $6\frac{1}{4}$ to $4\frac{1}{4}$ inches.

Fig. 1.—Sporangium of some mucor in a state of decay. Several were noticed paler and filled with yellowish granular matter.

,, 2.—Free spores numerous;—the dark oval ones possibly some form of smut.

,, 3.—Large pale sporange.

,, 4.—Mycelium with spores attached found abundantly in the pale or less discoloured part the of jelly mass. Mucor Racemosus (?)

,, 5.—Small pale mucoid masses unattached to any mycelium containing minute yellowish bacteroid bodies. Gonidial elements of one of the fungi.

Fig. 6.—Terminal portion of a mycelial filament.

,, 7.—Large dark sporangium (rare in this stage) taken from the stem of the mycelium (one of the Nidulariaca or Peresporacei).

,, 8.—Some form of spore ruptured from the bearing filament—perhaps some ascigerous stage of mucor.

,, 9.—Filament with circular terminal spore of mucor racemosus ?

,, 10.—Same as figure 8, but in a stage of decay.

,, 11.—Same seen attached to the mycelial filament.

,, 12.—Spore vesicle of mucor.

,, 13.—Small mass of minute spores ; very abundant.

,, 14.—Dark olive coloured oval spores ; some form of smut.

,, 15.—Leg of Acarus.

,, 16.—Vegetable spiral fibre, common, simple and double, found in considerable lengths.

,, 17.—Scale of gnat.

,, 18.—Globose olive coloured spores of ?

,, 19.—Ovum of ?

,, 20.—A young plant developed from a spore similar to those at the right of figure 13.

,, 21.—Two vesicles, or heads of some mucor, proceeding to the development of spores.

,, 22.—Egg case of some small insect, common.

,, 23.—One stage in the sporangium of figure 7, the granular mass undergoing segmentation.

,, 24.—Another stage of figure 7 or 23.

,, 25.—Yellow ovum, ruptured ; empty shell.

,, 26.—Ovum, supposed to be the same as figure 19.

,, 27.—Numerous faded heads of some mucor, attached to *very fine* mycelial filaments, very abundant in the slime.

,, 28.—A young plant of ?

,, 29.—Two stems with attached spores divided by a septum below the middle. Arthrobotrys ? one of the mucidines ? very doubtful, rare.

Fig. 30.—Pale mycelial filaments, very abundant, but without any form of sporange found developed.

,, 31.—Nid of small spider ?

,, 32.—Part of the body of a small Entomostraca—Canthocamptus minutus.—

,, 33.—A small Anguillula, many seen in the slime, but generally much decayed.

,, 34.—Ovum of ?

,, 35.—A Tardigrade, Macrobistus Huflandii ?

,, 36.—Small irregularly crystalline masses of carbonate of lime.

,, 37.—Dark coloured filaments of mildew.

,, 38.—Filaments of mucor racemosus (?) one discharging minute bodies from the end vesicle by pressure.

,, 39.—A minute form of some conferva ; (the same has been met with a day or two since with other conferva from a fresh water pond, only having the endochrome of a bright green colour).

,, 40.—Mildew attached to the mass of dark grumous granular matter so abundant in the slime.

,, 41.—A minute crystal octohedron showing colours distinctly, rare.

,, 42.—Part of the body of an Acarus, very abundant in all stages of development.

,, 43.—A very long and delicate mycelium, constant in the portions examined.

,, 44.—The central fig : An ovum with the embryo partly developed. The whole fig. gives the ordinary appearance under the microscope of the light coloured part of the slime and contains some of the bodies figured separately, minute bacteroid bodies abounded, but none were noticed in movement.

,, 45.—The general appearance of the dark part of the slime containing numerous small circular spores like fig. 13, and small dark irregular masses mixed with them.

,, 46.—A single filament of (?) with vesicle or peridiole attached.

,, 47.—A microscopic fungus supposed to be developed from a spore similar to the one to the left of the figure.

,, 48.—Peridiole of a mucor with unripe spores.

Fig. 49.—Fragments of vegetable tissue, common.

,, 50.—One of the chitinous segments near the thorax of a larva of a dipterous insect.

,, 51.—Ovum of? Tardigrade?

,, 52.—A young mildew.

,, 53.—Separated spores of arthrobotrys?

,, 54.—Pale grey mycelial filaments very abundant in the dark portions of the slime, some of a much darker tint.

,, 55.—Doubtful? An arachidon in one stage of development? (it has also somewhat the appearance of an entozoon).

,, 56.—Peridiole of a mildew covered with small spinous processes.

,, 57.—Two sporangia, supposed similar to fig. 8.

,, 58.—One stage in the development of the sporangium of fig. 8.

,, 59.—Simple and dotted vegetable tissue, abundant; the latter often in much larger pieces.

,, 60.—A small hematoid worm.

,, 61.—A mildew.

,, 62.—Dark grey filaments of mucor found chiefly in the discoloured portions of the slime due to the fœtid gases evolved by decomposition.

,, 63.—Supposed to be an ovum of?

,, 64.—Supposed early stage of some minute marine crustacea.

,, 65.—Small mass of irregularly crystalized carbonate of lime, many of the masses were more than quadruple this size.

,, 66.—Woody fibre.

,, 67.—Animal hair, wool fibre.

,, 68.—Sporangium filled with fine greenish granular matter.

,, 69.—Starch grain.

,, 70.—Supposed to be one stage of development of the peridiole of fig. 7

,, 71.—Curved attached somewhat acicular crystals.

,, 72.—Some octohedron crystalline form as in fig. 41 but colours much less brilliant. (The want of colour in the photographs is a disadvantage towards recognizing the various objects.)

At a Meeting of the Council of the Borough of Liverpool, holden on Wednesday, 9th day of August, 1871,

PRESENT:

JOSEPH GIBBONS LIVINGSTON, ESQ., MAYOR,

AND A FULL COUNCIL.

Read letter from Dr. Parkes and Dr. Sanderson, dated 3rd August, 1871, enclosing the second portion of their Report on the Sanitary condition of Liverpool.

Resolved—

That the same be referred to the Health Committee and printed, and a copy sent to each Member of the Council.

EXTRACTED FROM THE PROCEEDINGS,

JOSEPH RAYNER,

TOWN CLERK.

BITTERNE,

SOUTHAMPTON, 3rd AUGUST, 1871.

JOSEPH RAYNER, ESQ.,

TOWN CLERK OF LIVERPOOL.

SIR,

We have now the honour to forward to you the second and concluding part of our Report on the Health of Liverpool.

In ending this Report, we feel it our duty to ask you to convey to the Worshipful the Mayor our best thanks for the very great support and assistance he afforded us.

We have also to thank most cordially Dr. Trench, Dr. Taylor, Mr. Evans, Mr. Reynolds, and all the other Municipal Officers, who all seemed actuated by an earnest desire to aid us in our enquiry.

We shall be happy, indeed, if the enquiry contributes in any degree to an improvement in the health of the inhabitants of your great city.

We have the honour to be, Sir,

Your most obedient Servants,

E. A. PARKES, M.D.

J. BURDON SANDERSON, M.D.

REPORT ON THE SANITARY CONDITION OF LIVERPOOL, BY E. A. PARKES, M.D., F.R.S., AND J. BURDON SANDERSON, M.D., F.R.S.

PART II.

In this section of our Report, we proceed to enquire into the causes of the high mortality which has existed for so many years in Liverpool. On this subject, we have found much information in the works of Dr. Duncan and Dr. Trench, and others, and in the instructive evidence given before the Mortality Sub-Committee of 1865. But we have endeavoured to work out the question for ourselves, and for this purpose obtained from the Registrar-General's* permission to make use of the Statistical Returns in the Office in London.

From these Returns, and from those taken from Dr. Trench's Annual Reports, we proceed to state—

1. The mortality of Liverpool as compared with other large towns.

2. The comparative mortality of districts in Liverpool itself.

3. The comparative mortality of certain streets in Liverpool.

4. The sanitary condition of those streets, and, by inference, of others like them.

In conclusion, we will state the practical recommendations to which our examination has led us.

I. Comparison of Liverpool with other large Cities.

Years.	Annual Mortality per 1000 living. Liverpool Registration District.†
1861	32·4
1862	33·7

* We must express our thanks to the Registrar General for this permission, and to Dr. Farr and other Officers of the establishment for their kindness and assistance.

† The Registration district is the parish of Liverpool, and not the borough, and includes the sub-registration districts of St. Martin's, Great Howard, Dale-street, Islington, St. George, St. Thomas, and Mount Pleasant. The calculation is made on the mean annual population as determined by the Census of 1861 and 1871.

Years.	Annual Mortality per 1000 living. Liverpool Registration District.
1863	37·6
1864	41·7
1865	*44·0
1866	†50·7
1867	35·4
1868	35·3
1869	36·3
1870	38·8
Mean of 10 years	38.59

In the same ten years, the mean annual mortality per 1,000 of population, calculated upon the mean annual population of 1861–1871, was as follows in the undermentioned towns.

Bristol	22·5
London	24·3
Hull	24·9
Bradford	26·2
Sheffield	27·2
Leeds	28.0
Manchester	30·2

Liverpool has a far higher average mortality than these seven large seaport or manufacturing towns. It is well known also to have constantly a very great excess of mortality as compared with Birkenhead.‡

The mortality in Liverpool may be divided into two categories—ordinary and extraordinary. The ordinary annual mortality in years not marked by any great epidemic disease is about 35 per 1,000 of population.§ In the years with epidemic outbreaks of Typhus, Cholera, or diseases of that class, it may amount even to 50 per 1,000, or 1 in every 20 of the population. This division, into normal and specially unhealthy years, is common to all towns, and affords a natural division of the inquiry into the causes of mortality.

To take the latter first. When epidémic diseases prevail frequently in a town, and cause in certain years an excessive mortality, they arise from two chief causes; 1st, the ready and frequent introduction of the cause of the

* Typhus Epidemic. In some other years also Typhus prevailed.

† Cholera Epidemic, Typhus and Diarrhœa.

‡ Dr. Baylis has been kind enough to give us the annual mortality per 1,000 in the Townships of Birkenhead and Claughton. It is as follows:—

YEARS.	ANNUAL MORTALITY PER 1,000.
1866	22·53
1867	20·84
1868	21·05
1869	19·76
1870	19·00
Mean of 5 years	20·64

Therefore in non-epidemic years the mortality of Liverpool is to that of Birkenhead as 7 to 4.

§ For this mean we have taken the six years, 1861, 1862, 1863, 1867, 1868, and 1869.

disease into the town; and 2nd, local conditions which always foster it or which allow its spread when introduced.* Both these causes exist in a high degree in Liverpool. Its position as the great seaport of the kingdom, for emigration, as well as for commerce generally, renders the arrival and departure of persons more frequent than in any other town of its size, and consequently increases greatly the chances of the introduction of any epidemic disease capable of being carried and imported, either from the continent of Europe or from Ireland. The introduction of Typhus, Cholera, Smallpox, or Relapsing Fever is therefore almost certain, if these diseases prevail in places with which it is in frequent communication.

It is not possible to alter this without surrendering the commercial supremacy of Liverpool, but some precautionary measures may be taken. Arrangements for the proper and healthy accommodation of emigrants, both Continental and Irish, so as to separate them completely from the permanent population, by locating them only in a certain district, would afford the best chance of stamping out or limiting the spread of an epidemic disease brought with them; and although it might not be possible to do this in the case of Irish, or othe labourers, who enter Liverpool in search of work,† still, even here precautions might be taken, whenever it is known that epidemic diseases are prevailing in the localities whence they come. As it is of such importance to Liverpool to receive early intimation of any epidemic disease prevailing in Germany and the North of Europe, or in Ireland, we suggest that arrangements should be made to obtain regular monthly Reports of the health of those countries as regards epidemic diseases, so as to be prepared for any contingency of the kind. But the local causes which aid the spread of these diseases (and which are all important as being removable) exist also in Liverpool to an unusual extent, as we shall show in a subsequent part of our Report.

Passing from the unusual to the ordinary mortality, we have to enquire why Liverpool should in this respect be less favourably placed than Bristol, London, or Hull.

II. Mortality of Districts.

In the following table, taken from Dr. Trench's Annual Reports, we give the mortality per 1,000 in the inhabitants of the districts after correction has been made for the deaths of persons contracting the diseases in the district, but dying in public institutions situate in other parts of the town.

* There may be general atmospheric conditions in addition to the two noted above; but if so, they have not been yet recognized with sufficient scientific precision to render it desirable to discuss them in this place.

† In 1868, as many as 5,000 vagrants entered the vagrant sheds of Liverpool in one week; and, in the summer months especially, this immense movement is paralleled every year.

Districts.	Years.					
	1865	1866	1867	1868	1869	1870
Scotland	38·6	43·4	26·8	28·2	27·9	29·1
Vauxhall	49·0	62·0	35·3	33·2	38·8	43·9
St. Paul's and Exchange	48·2	46·7	33·7	34·5	31·9	36·2
St. Anne's and Lime Street	45·5	47·9	33·3	31·6	34·3	36·3
Castle Street and St. Peter's	26·5	27·4	20·2	17·7	18·9	18·1
Pitt and Great George	32·0	43·4	29·4	31·3	29·3	34·6
Rodney and Abercromby	23·7	26·1	21·5	20·0	20·6	21·9
Everton and Kirkdale	29·5	32·6	24·9	26·7	26·6	26·4
West Derby	24·6	29·0	25·1	23·2	22·1	24·4
The Toxteths	32·2	37·5	24·5	27·7	27·6	33·0

These returns show at once that the ordinary high mortality of Liverpool is not distributed over the whole town. There are districts, such as the Rodney and Abercromby, Castle Street, and St. Peter's Wards, where the mortality may compare favourably with any town in England; while, in other districts, as in Vauxhall Ward, and St. Paul's and Exchange, a mortality, always excessive, reaches sometimes a most alarming height. This table at once does away with any question of an insalubrious climate being the cause of the high mortality in Liverpool. The difference must be connected, not with general conditions of climate, but with locality, and, if so, must arise either from conditions of soil, local sanitary faults, modes of living, or from occupations and personal habits.

III. Mortality of Streets.

To carry this statistical analysis farther, it is best to deal with limited areas. We have, therefore, selected certain streets which appeared to us to fairly represent those inhabited by the poorer classes in Liverpool. In addition to the information gained by personal inspection, statistical returns were procured of the population of these streets, and of the mortality during the last four years.

The tables are founded on data obtained from the Registrar's returns in London, and on lists of deaths obtained from the public Institutions in Liverpool, by means of which we have been enabled to refer back to the streets the deaths of residents occurring in the hospitals or infirmary. If any error exists in these tables, it must arise from some of the deaths in public

institutions not being properly traced to the streets, and the effect of this would be to make the mortality of these streets less than it should be. We do not think the error is great, and if it exists at all, it only strengthens the argument based on these tables.

For the purpose of a standard of comparison, we selected two healthy streets after consultation with some of the medical men of Liverpool, viz., Rodney and Egerton Streets. Rodney Street is mainly inhabited by a very respectable middle class; the number of children is small, and the average age of the population high. Egerton Street is inhabited by a class of skilled artizans getting good wages, clerks, custom-house officers, and other respectable persons. The other selected streets are inhabited by the lower class of labourers.

We have taken the mortality for the four years, 1867–70. As in the year 1866, there was an epidemic of Cholera, we have not included it, as we desired to see the results of the operation of the ordinary causes of mortality. And we have used the Census returns of 1871; for as there has been no alteration in building in these streets, we believe the population of 1871 represents as closely as possible the population of the four previous years.

TABLE

SHOWING THE TOTAL MORTALITY OF BOTH SEXES, AND OF ALL AGES, IN CERTAIN STREETS.

Street.	Character of Inhabitants.	Total Population Census of 1871.	Deaths from all causes in 4 years, 1867–70.	Mortality per 1000 per annum, calculated on the Census of 1871, all ages.
Rodney	Respectable First and Second Class Houses inhabited by well to do persons.	607	26	10·71
Egerton	Clerks, Custom House Officers, and Skilled Artizans.	357	38	26·61
Henry Edward	Poor Population, Artizans, Dock Labourers, &c., &c.	677	81	29·91
Adlington	..	936	120	32·10
Bispham	..	716	92	32·12
Lace	..	715	102	35·70
Addison	..	688	125	45·40
Sawney Pope	..	1016	227	55·86

It appears from this table that Rodney Street is remarkably healthy, and would probably contrast favourably with any village in the country of 600 inhabitants. Egerton Street has a mortality which is considerably below that of the town in general (as 26 to 35), though still its deaths are higher than they should be. The death-rate increases gradually in the other streets on the list, until in Addison and Sawney Pope Streets it reaches the enormous amount of 45·4 and 55·86 deaths per 1000 per annum. From this table it perhaps may be inferred that the large ordinary mortality of Liverpool must be owing chiefly to the great number of streets, which, like Lace and Bispham Streets, have a high though not excessive death-rate, but in part also to the excessive mortality of certain streets like Addison and Sawney Pope Streets.

The idea that there is something unhealthy in the climate of Liverpool is again sufficiently disposed of by the fact that a street like Rodney Street, well elevated, wide and airy, and inhabited by a respectable class, presents a degree of healthiness to which it might be difficult to find many parallels in the most healthy towns.

We proceed to analyse the table, and first must apportion the mortality to age.

TABLE

TO SHEW THE MORTALITY TO POPULATION UNDER ONE YEAR, AND UNDER FIVE YEARS OF AGE.

Street.	Persons living under 1 year of age at the Census of 1871.	Death of persons under 1 year of age in 4 years, (1867-70.)	Annual mortality per 1000 of the population under 1 year of age.	Persons living under 5 years of age at the Census of 1871.	Deaths in 4 years under 5 years of age, (1867-70.)	Annual mortality per 1000 of the population under 5 years of age.	Percentage of deaths under 5 years to total deaths at all ages.
Rodney	5	1	·50	26	4	38·46	15·38
Egerton	13	12	230·7	40	17	106·25	44·7
Henry Edward	20	17	212·5	83	38	114·5	46·9
Adlington	26	31	298·1	112	57	127·2	47·5
Bispham	21	22	261·9	100	56	140·0	60·87
Lace	9	21	583·3	61	40	163.9	39·2
Addison	19	18	236·8	89	45	126·4	38·0
Sawney Pope	32	51	398·4	102	106	259·8	46·67
Healthy districts in England (Farr)	..	..	..	..	..	40·36	..

From this table it appears that out of 100 children under one year of age, only 5 die annually in Rodney Street; 58 die in Lace Street; 40 in Sawney Pope Street; 30 in Adlington Street; and from 21 to 26 in the other streets; Egerton Street in this respect, is even worse than Henry Edward Street.

If, however, as giving a safer guide, we take the mortality among 100 children under five years of age, there die annually (in round numbers)

In Rodney Street	.. .. ..	4 Children.
" Egerton Street	.. .. ..	10½ "
" Henry Edward Street	.. ..	11½ "
" Addison Street	.. .. ..	12½ "
" Adlington Street	.. .. ..	13 "
" Bispham Street	.. .. ..	14 "
" Lace Street ..	.. .. ..	16 "
" Sawney Pope Street..	.. ..	26 "

This table brings out clearly the enormous death-rate of children; it would hardly be credited that even the advantages of Rodney Street, in point of situation and of class of people, would make a difference so great.

It seems a frightful circumstance that in the same town there should be a contrast so appalling as that between Rodney Street and Sawney Pope Street. Even Egerton Street, though inhabited by so respectable a class of people, does not in this respect stand so well as it should do.

This table proves also, from the last column, that the great mortality in the poor streets arises partly from the loss of life of children under five years of age. In Sawney Pope Street it may be said that of every two deaths, one is of a child under five years of age, and in Bispham Street, the proportion is even higher, and is not very far from giving two deaths of children to one of persons over five years of age.

That this is not simply a condition belonging only to these streets, but extends over a large part of the town, is shown by the following table, taken from Dr. Trench's able Annual Reports.

[TABLE.

TABLE.

Wards	Per centage of Deaths of Persons under 5 Years of Age to total Deaths. Years. 1868.	1869.	1870.
Scotland	62·4	60·5	62·9
Vauxhall	60·1	60·0	56·1
St. Paul's	55·1	52·6	51·1
Exchange	52·1	49·1	46·0
St. Anne's	61·0	59·0	54·9
Lime Street	50·8	41·6	51·3
Castle Street	32·3	42·6	41·3
St. Peter's	46·3	44·1	42·4
Pitt Street	49·3	47·1	53·7
Great George	53·2	48·2	54·4
Rodney	44·3	42·4	47·1
Abercromby	44·3	42·4	47·2

So that the numbers in some of the selected streets are even below the amounts in the districts, proving both that there are streets still worse than those selected, and that the bad streets must be extremely numerous.

It may be interesting to compare these numbers with those of some good and bad streets in London. In Dr. Buchanan's Reports of the mortality of some of the worst streets in St. Giles (viz., Church Lane, Dudley Street, and Short's Gardens), as compared with the fine open adjacent squares of Russell and Bedford, we find the following numbers.*

[Table.

TABLE

TO SHOW MORTALITY IN SOME LONDON STREETS.

Place.	1861. Annual mortality per 1000 of population, all ages. Total.	Under 5 years.	Percentage of deaths under 5 years to total deaths.	1862. Annual mortality per 1000 of population. Total.	Under 5 yrs.	Per-cent.	1863. Annual mortality per 1000 of population. Total.	Under 5 yrs.	Per-cent.
Bedford Square	12·9	3.3	26·6	17	6·1	37·9	16·2	6.1	37·6
Russell Square	14·2	3·9	27·4	13·5	4·0	29·6	12·9	2.7	16·0
Church Lane, St. Giles	30·6	16·5	54·0	34·2	16·6	48·6	30·1	13·4	44·6
Dudley Street, St. Giles	32·4	16·2	50·0	31·1	15·9	51·2	30·9	17·2	55·5
Short's Gardens, St. Giles	34·7	16·6	47·9	39·1	15·4	39.4	37·7	17·8	47·3

On comparing this table with those of the Liverpool streets, it appears that there are streets in Liverpool as healthy as these fine squares in London, and that there are streets in St. Giles in London which have a mortality equal to many of the Liverpool streets, though certainly even St. Giles' does not approach the great mortality of Addison and Sawney Pope Streets.

The mortality of children under five years in St. Giles', assumes, however, relative proportions as great as in Liverpool, and doubtless owns the same causes. But what makes the great difference between the two cities, is that in Liverpool there is a large relative proportion of streets with high mortality,† while in London, the mean mortality of the whole city is reduced by the preponderance of healthy streets and districts.

The effect of the excessive infant mortality of Liverpool is to reduce the average age at death. That is, if the total years at death of all who die are

* We have not been able to put the table in precisely the same form as that of the Liverpool streets, as we do not know the number of the population at the different ages, but the table as it is tells its own tale.

† According to Dr. Trench's estimate, founded on the statistics of registered houses, the proportion of the Liverpool population now inhabiting houses of the same class as our selected streets amounts to one-third of the whole.

divided by the number of deaths, the average age at death is, in some wards only 14 years, and in one or two cases is reduced to 10 years, while in the Borough at large it is 22 or 23 years.

What then are the diseases which cause this great mortality of children in Liverpool? To answer this, we give a table showing the diseases and the number of deaths, caused by each disease in four years, in the selected streets.

TABLE.

DISEASES CAUSING DEATHS OF CHILDREN UNDER FIVE YEARS OF AGE IN FOUR YEARS (1867-70) IN THE SELECTED STREETS.

	Streets.							
	Rodney.	Egerton.	Henry Edward.	Adlington.	Bispham.	Lace.	Addison.	Sawney Pope.
Small Pox	..	..	..	1	1	..	1	2
Measles	..	3	3	5	4	1	7	7
Scarlet Fever	..	..	2	3	4	3	..	7
Typhus	..	..	..	..	1	..	..	1
Simple continued Fever	..	..	..	..	..	6	1	2
Relapsing Fever	..	..	..	1	..	..	..	1
Diarrhœa	1	..	3	5	7	4	3	12
Phthisis	..	1	..	..	1	..	1	1
Convulsions	..		3	9	10	3	3	7
Bronchitis	..	2	3	9	8	5	4	16
Pneumonia	..	1	3	1	1	1	5	3
Laryngitis	..	..	..	..	..	..	..	1
Atrophy and Debility	1	2	8	7	7	6	11	17
Violence	..	..	4	3	3	1	..	6
Ill defined	..	..	..	2	..	..	..	1
Other causes	2	6	9	11	9	10	9	22
Total	4	17	38	57	56	40	45	106

The mortality of children under five years is seen by the tables to be owing to five principal causes. 1st, The exanthemata, viz., the contagious diseases of childhood. 2nd, Diarrhœal affections. 3rd, Bronchitis and Pneumonia. 4th, Atrophy and Debility; and 5th, Convulsions, &c.

Taking only the six poor streets, we find that 342 children died in four years, and of these—

51	died of	Small Pox, Measles, and Scarlet Fever.
34	„	Diarrhœa.
35	„	Convulsions.
59	„	Bronchitis and Pneumonia.
56	„	Atrophy and Debility.
235		

A large number of deaths from the contagious diseases of childhood must be expected in a crowded population where removal and isolation are impossible. But the other large causes of mortality tell their own tale to all medical men; the large numbers put down to atrophy and debility and to convulsions, indicate unmistakably the greatest neglect and maltreatment on the part of the parents; while the high death rate from the acute affections of the lungs indicates as certainly insufficient clothing, and exposure, and the effects of breathing fœtid and poisoned air. From this table alone, it might be confidently predicted that the people, among whom such a high death rate occurs from these causes, are not only poor, but are careless, ignorant, and probably barbarous in their modes of life.

The table brings out another point, viz., that infantile remittent fever (in other words enteric fever) does not in ordinary years cause any considerable mortality, while the diarrhœal affections are not excessive. This probably indicates that both the drainage and water supply are fairly good.*

The great death rate of Liverpool in non-epidemic years is therefore in some measure owing to the great mortality of children.

But this will not account for all. The mortality in these streets is in excess at every age, both in comparison with all England, and with the healthy districts in England.

This is shown by the following table—

* There are other causes of infantile mortality which do not appear in the table. The smothering of infants by drunken mothers adds to the mortality, (evidence of Mrs. O'Brien in Mortality Sub-Committee's Report, p. 146, and of Mr. Roberts, ibid. p. 165.) No doubt, also, injuries to children have a considerable effect, which are not reported as deaths by violence.

Annual Rate per Cent. of Mortality from All Causes at Each Age at and above 5 years.

Streets.	Ages. 5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Lace	1·16	·82	·45	1·17	3·80	·46	1·79	1·96	3·21	5·10	4·61	7·43	12·50	..	..	..
Bispham	1·84	·85	..	·71	·78	1·12	1·92	1·13	3·06	2·50	3·57	1·61	..	6·25	..	25·00
Sawney Pope	1·46	1·16	1·67	3·21	2·97	3·33	4·41	2·42	5·73	7·33	4·55	5·15	28·57	16·67	..	..
Addison	1·90	·88	·41	2·03	4·17	3·02	2.70	2·63	6·25	7·14	6·25	6·43	20·83	5·00	75·00	..
Adlington	·44	·26	·31	1·47	1·22	1·51	3.45	3·67	3·98	2·36	5·43	4·63	12·50	..	25·00	25·00
Henry Edward	2.45	·67	..	1·02	1·67	·96	1·22	·86	2·94	3·75	3·26	5·00	3·57	4·17	..	..
Healthy Districts in England, both Sexes	·688	·431	·728	..	·857	..	·964	..	1·232	..	2·228	..	5·228	..	12·304	..
All England, mean of 30 years, 1838–1867 Males	·879	·495	·790	..	·993	..	1·303	..	1·816	..	3·153	..	6·854	..	14·774	..
All England, mean of 30 years, 1838–1867 Females	·867	·510	·822	..	1·230	..	1·231	..	1·567	..	2·856	..	5·752	..	13·536	..

At every age (except of that at 15 years, when the numbers are small, and give probably too low an estimate), the mortality is far higher in the selected streets than in the healthy districts of England, or than in all England. A glance at the numbers is sufficient to show the immense excess of death rate of these streets. An instance or two will illustrate the table. At 35 years of age, when life is most vigorous, 1,000 persons of that age in the healthy districts of England lose only 10 lives in a year, Bispham Street loses 20, Adlington Street 34, and Sawney Pope Street 44.

At 45 years of age, in the healthy districts of England, only 12 die out of 1,000 persons; 57 die in Sawney Pope Street, and 62 in Addison Street, while the lowest mortality, viz., 29 in Henry Edward Street, is still nearly 2½ as much as in the healthy districts.

We must now turn to the causes of this excess of mortality in persons above 5 years of age. In the six selected poor streets (viz., Henry Edward, Lace, Bispham, Adlington, Addison, and Sawney Pope), there occurred in 4 years 405 deaths in persons above five years of age; and the following were the chief entries in the Registration Returns.

Diseases.	No. of Deaths.	Per Centage to total deaths in persons above 5 years old.
Bronchitis	134	33·1
Phthisis	76	18·7
Simple continued Fever	22	5·4
Typhus (exanthematic)	12	2·96
Enteric Fever	2	·5
Relapsing Fever	6	1·48
Intemperance and Delirium Tremens	9	2·22
Total from these causes	261	
All other causes	144	
	405	

In Egerton Street, out of 21 deaths in 4 years, there was one death from simple continued fever, 1 from enteric fever, and none from bronchitis.

The zymotic diseases in this table give quite insignificant numbers, for the term "simple continued fever" is probably applied to any febrile state not attended with such symptoms as indicate plainly either enteric or typhus fever, or local disorder, and it therefore rather represents a class than a single disease. The great causes of mortality in these streets are lung affections; for however loosely the term bronchitis may be used, it can hardly, in the most careless returns, refer to any disease except some acute or chronic affection of the lungs. Bronchitis and phthisis appear to be the chief causes of the mortality of persons over five years of age, in the years which are free from great epidemic disease; and in these streets, these two headings account for nearly 52 of every 100 deaths in persons above five years of age. This contrasts with the mortality caused by bronchitis and phthisis among children. Out of 342 children under five years of age dying in the same streets in 4 years, only 47 died from bronchitis, and 4 from phthisis. This is a considerable mortality, but it is nothing as compared to that in the older persons from the same causes.

If we turn to the general statistics of the town, as given in Dr. Trench's Reports, we find that bronchitis and phthisis give formidable figures of mortality; but still, these are below those of the selected streets. We, therefore, infer that, in non-epidemic years, the causes of the larger mortality in persons over 5 years living in these streets, over the mortality of the town at large, is owing to these two diseases, or perhaps we should more correctly say, classes of disease.

The prevalence of bronchitis and phthisis, as causes of large mortality, is not peculiar to Liverpool. It is marked in many other large towns, particularly in Glasgow, and enough is known to enable us to say, that it is not dependent on climatic conditions. For example, as shown by Dr. Gairdner, it is far more common in Glasgow than in Aberdeen or Perth. Its causes appear, from Dr. Gairdner's researches, not to be industrial in Glasgow; *i. e.*, lung affection there is not specially connected with inhalation of solid particles arising in the operations of trade. In Liverpool also, it does not appear to us that we can look to special deleterious occupation for its cause.

To what this high rate of mortality from lung diseases in these streets is owing will be considered when we have described the streets themselves.

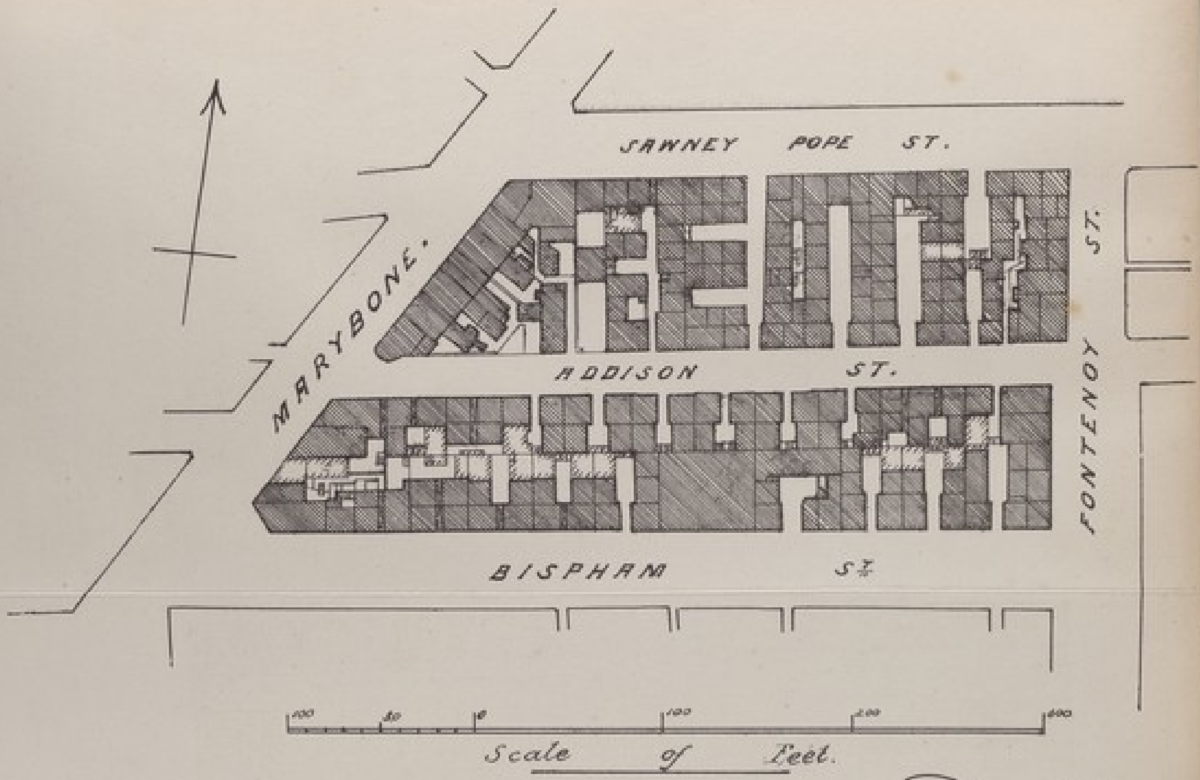
IV. The Sanitary Condition of the Selected Streets.

We made a prolonged examination of the selected streets, and of many others in the neighbourhood, and visited them by night as well as by day.

The selected streets are not in the lowest part of the town, and are from 50 to 56 feet above ordnance datum line. They are built on clay ground, from which the clay has been more or less removed for brick making, and the excavations have been, in many cases, converted into cellars.

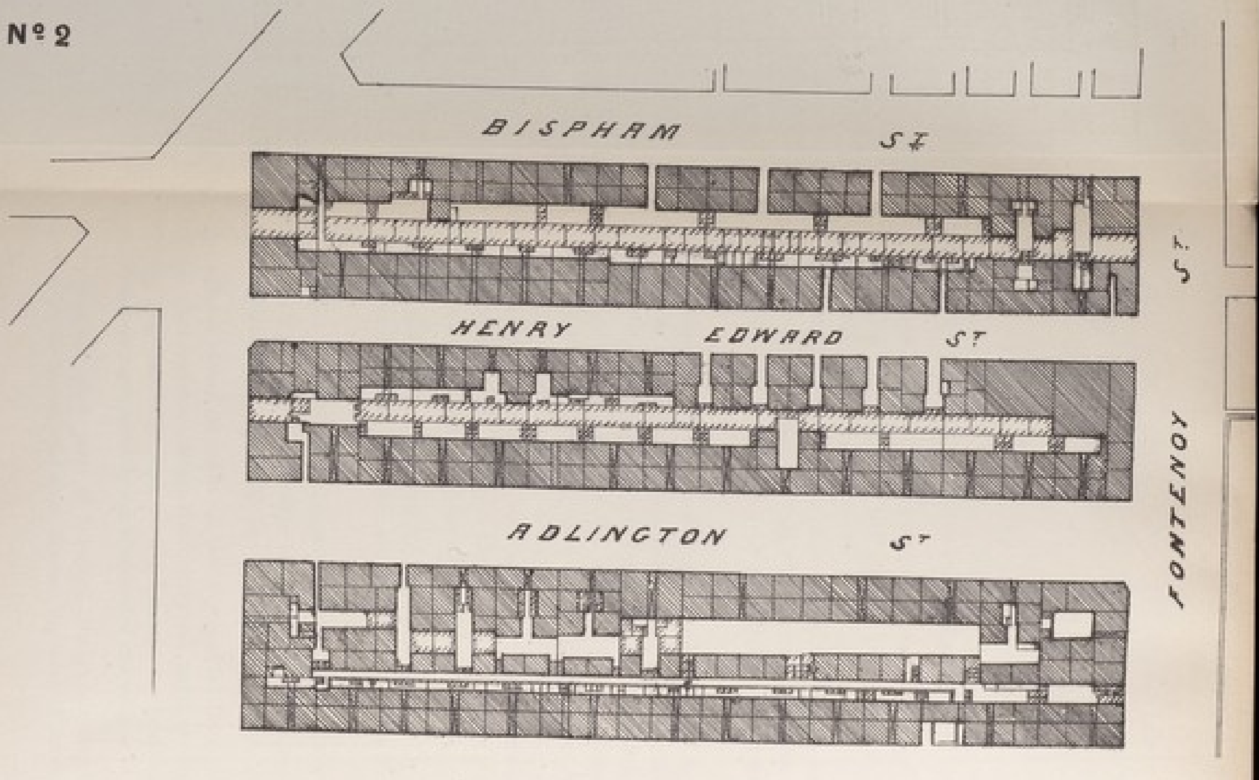
As in so many other parts of Liverpool, the streets contain the smallest proportion of the houses; the space between the backs of the houses of parallel

PLAN Nº1



C. Davies

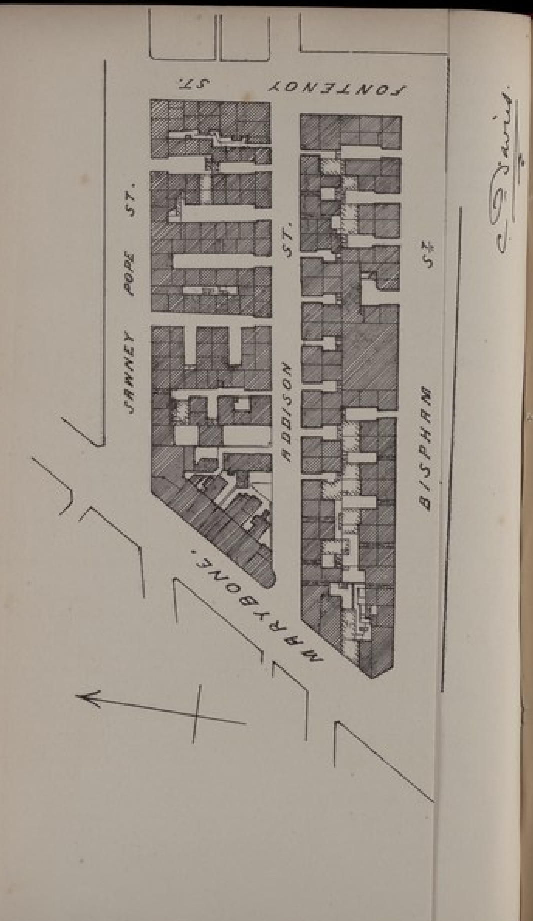
AN Nº2



NOTE: Property demolished under Sanitary Presentment Act, shewn thus

C. Davies.

PLAN No 1



streets is occupied by courts. In these courts, the houses are packed closely together with an ingenious economy of space which does credit to the builders, though Liverpool has little reason to be thankful for it.

We give a tracing showing the arrangement of the selected streets, where a population of nearly 5,000 people are crowded into a space which, at a liberal calculation, does not exceed 23,500 square yards, or the compression of the population nearly equals 1,000 persons to an acre. The red shading marks the buildings which have been removed by the Corporation improvements. The tracing shows sufficiently the arrangement of the houses back to back, the complete blockage in many cases of air and light, and the practical impossibility of thorough ventilation. Formerly, the narrow spaces in the courts were also blocked with enormous middens, which, in many cases, were close to doors and windows, but these have all been removed.

Within the courts, each house is usually found to consist of a room on the ground floor, a room above this, and a third room in the attic. Most of them have cellars. It very frequently happens that there is a family in each room except the cellar. In many cases, the staircase forms part of the rooms, and is without any window, so that, in fact, there is an inevitable mixture of the air contained in all the rooms. Few constructions could be better adapted for the spread of contagious diseases. In most houses in London inhabited by the poor, a separate staircase exists with landings, from which the rooms open, and there are windows permitting entrance of air. By this means, polluted air escaping from the lower rooms into the staircase is diluted, and more or less completely carried off; but in Liverpool, even this amount of ventilation is wanting.

The cellars in these streets are not now inhabited (though cellar habitations are found in other streets), but are either empty or used as lumber rooms. In many of them there is a water tap, and a trapped inlet to a drain to carry off the water. We have already observed, in the first part of this Report, how frequently it happens that the trap of the drain is broken or removed; and we must also notice that, in several instances, the floor of the cellar was soaked with water from the dripping of the tap, in consequence of the imperfection of the inlet. With reference to these evils, we believe that they can only be remedied by carrying out the recommendations on this subject contained in the first part of our Report (p. 19), viz., by insisting on the placing of all inlets to the sewers outside of the houses, in such positions that they can be safely inspected and repaired.

But, in addition to this, we found the floor of the cellars, in several cases, in a very foul condition. Impurities of all kinds had been deposited there, and in this way the air of the house was constantly contaminated from the basement.

As we believe that it is not possible to keep these cellars clean without constant inspection, we are of opinion that they must be so closed as to render them inaccessible to the occupants of the houses or courts. Before doing so, it will be necessary to cleanse and lime-white them; sufficient apertures (air bricks) must also be left for ventilation.

With regard to the cleanliness of these houses, it was clear that a good deal had been lately done in several houses by lime-washing the walls, and by compelling the people to clean the houses.* The epidemic of relapsing fever had probably led to this. But, in spite of this enforced cleaning, nothing could exceed the dirt of the people and the fœtid condition of the atmosphere at night. How human beings could tolerate such a state of things would be incredible, if we did not know the deadening influence of custom. The peculiar construction of the houses and the entire want of ventilation intensify the effects of this almost universal uncleanliness. For it is almost impossible also, sublet as the rooms are in most of these houses, for the people in one room to be clean while others are dirty. They give up the attempt in despair.

Accordingly, the only clean houses we saw in these courts were those in which only one or two families lived.

The causes of this fœtid atmosphere are the effluvia due to filth of the persons and clothes; the exhalations from the untrapped drains and wet filthy

* In an interview which one of us had with the Land and House Owners Association, a strong opinion was expressed by some of the members of the Association that the habits of the people are very much dirtier now than they were before 1847. At that time the cleanly poor would insist on a dirty person removing from a court, and the owners of property were obliged to compel them to leave for fear of losing their other tenants; but now that sense of cleanliness seems lost even by the English, who were formerly very clean. This increasing dirtiness is attributed to a great extent to increasing poverty and intemperance; but, in addition to these, another cause was assigned. It was stated (by Mr. Owen Williams) that the owners are now powerless to compel their tenants to keep the houses clean, and even in some cases to pay their rent. If they attempt to do so, the tenants go to the Health Officer, and in a few days the owners receive notice to clean the houses. It was alleged by the Members of the Association, that the owners are thus put to such an expense, that they no longer dare to interfere with the tenants, and the opinion was expressed that the houses of these poor classes would be much cleaner if the owners, as in former times, were allowed to look after their tenants at their discretion.

Whatever may be the facts as regards this, it seems clear that any state of things which indirectly throws the responsibility of cleanliness off the tenants must be wrong. The inmates who allow a house to become filthy ought to pay for it, and not the owner, who may have little control over his own property. The keeping the houses in sanitary repair is another matter.

floors of the cellars; the excretions of the skin and lungs which are not removed by ventilation; the effluvia from fish and other food; and the dirt of the walls, floor and furniture when there is any.

When we visited these courts at night, it was singular how pure even the air of the courts appeared after coming out of the almost insupportable fœtor of the sleeping rooms. We ought to state that we visited these courts during cold weather, when windows are less frequently opened than in summer.

With reference to the number of persons living in these houses, a very strict supervision is maintained by the Officer of Health, and inspections are made at night at frequent though variable intervals, to see that there are not more persons sleeping in any room than the number fixed for it by regulation. Summonses are taken in all cases in which the fixed number is exceeded. This system has no doubt lessened overcrowding, and materially improved the condition of the houses. If the atmosphere is now so bad as we have described, what must it have been before this system of inspection was introduced?

The lodging-houses which are all ventilated and kept clean, presented a considerable contrast to the houses in these courts. The air was comparatively pure, and we saw the lowest kind of tramps sleeping in rooms far healthier and cleaner than the houses of dockyard and other labourers.

With regard to the people and furniture in these houses, we were not at all prepared either for the wretched appearance of the people, or for the terrible aspect of poverty disclosed.

All this is so familiar to the Town Council and to the Officers of Health, that we feel we are going over ground too well known. But it is necessary to the completeness of our sketch to state, that we could not have believed that in any town in this country we could have gone into room after room, and house after house, and have found in so many cases literally almost nothing but the bare walls, a heap of straw covered by dirty rags, and possibly the remains of a broken chair or table. In London, and every large town, such rooms may be found, but the peculiarity of Liverpool is, that they are so numerous. Of course there are houses and rooms fairly furnished, and we are not able to give a numerical statement of the relative numbers of these unfurnished rooms, but in one or two streets, and in several courts, they were, we think, in the majority.

We were much struck by two circumstances in these houses, in addition to the want of furniture. There were no cooking utensils of any kind, or only an old saucepan. The inmates then depended for the means of rudely cooking what food they could get (in our visits chiefly fish and bread) on a neighbour's kindness. The second point, was that it was evident many persons had no change of clothes. On pressing the enquiry as to how they washed, and what they did at night, we extracted from several that they occasionally washed their hands and faces at the tap, but seldom removed their clothes. In some cases, both of men and women, we made out that the clothes had not been removed for several weeks. In our visit at night, we sometimes found that the clothes had been partly removed, and were then drawn over the person. Some men, indeed, were in bed quite naked, lying on the straw, and covered with their clothes.

The influence of such a mode of life as this on health in general, and in particular on the propagation of typhus and other contagious diseases in this way, need not be insisted on.

The impression made upon us by these circumstances has been so deep, that we may unconsciously exaggerate their frequency. It must be remembered that we are referring only to the worst parts of the town, and we should be sorry to apply this description to the houses of the mass of the labouring population in Liverpool. But certainly we can safely say, that the relative number of these houses, and of the people living under these conditions, is much greater in Liverpool than in other towns of which we have knowledge.*

With regard to the causes of this condition of the people, all to whom we have spoken attribute it to three circumstances: the irregularity of the labour market, the improvidence and careless habits of the people, and especially of the Irish, and the great intemperance.

On this last point we are aware that numerous investigations have been made in Liverpool, and that no additional evidence is needed from us. But following our course of independent enquiry, we endeavoured to make out what part intemperance played in producing this poverty and all its attendant evils. We cannot doubt that it plays a very large part. We have, in our note books, the replies given by many of the poor people whose rooms we entered. Many of them at once attributed their condition to drink; others owned it on being pressed on the matter. Several women gave an exact statement of what their husbands earned, and what they brought home. We select two examples of

* Dr Trench, in his Annual Reports, has directed attention to another point on which we did not specially collect evidence, viz., the number of adults of the two sexes, fathers and daughters, mothers and sisters, or strangers, sleeping in the same room, and often in the same bed. This is a feature of all our large towns, and is well known to be a most fruitful source of evil of all kinds. It is unnecessary to do more than to allude to it.

workmen, in whose cases there was no irregularity of employment. A tin-plate worker in constant work earns 22s. a week. He has a wife, evidently a careful respectable woman, and four children. In reply to questions, she said he drank a little, then owned "he drank very heavy." "Sometimes he brought home 18s., sometimes 16s., sometimes 12s.; last week he drank it all. If he would bring 22s. a week, she should be happy as the day is long." This family (six persons) were living in one back room, for which they paid 1s. 6d. a week; it was 10½ feet long, 9 feet broad, and 8¾ feet high; the furniture was a bed, table, and two ricketty chairs. Two of the four children were sick. In the front room of the same house, the rent of which was 2s. a week, a man and wife, a daughter aged 17, and a son aged 15, lived; the man earned 24s. a week, and passed his time in drinking hard, repenting and saving, and then drinking again; the wife "drank all she could get." The son and daughter earned next to nothing.

Here we have two cases, of constant employment and good wages associated with utter poverty, to end, no doubt, in relief from the rates and death in the workhouse.

When the occupation is uncertain, like that of the dockyard labourers, the case is nearly the same; the temperance, which is enforced from time to time by destitution, is compensated for at the first opportunity on the return of plenty.

Instances of this kind seem to occur so frequently in all the poor districts of Liverpool, that we question whether 20 per cent. of the labouring class in these streets are leading lives of ordinary restraint and decency.

It does not appear that the bad trade of the last few years has lessened the amount of drinking: all agreed that there is much more than formerly.*

In order to form as correct an estimate as possible of the amount of drunkenness in certain parts of Liverpool, we applied to a source on the accuracy of which we place the greatest confidence, although we are not permitted to name it.

Data connected with most of the houses in one of the apparently most

* In order to collect evidence, we applied to various parties, and, among others, we were advised to apply to a man who had been a landlord of a small public house in one of the selected streets. He had lived for years in the district, and knew intimately the habits of the people. He told us that "for one man who did no drink, there were 50 who would take their share; they starve their wives and children, and must beg if they want a bit."

destitute streets were submitted to us; the large wages which can be earned with comparative regularity, and the amount which is spent in drink, are astonishing. One or two instances of the worst kind (if there is really any distinction) occurring in the same street may be cited.

A man earns 27s. regularly, and spends as regularly 21s. in drink; his four children are in rags.

In another instance, the wages are 30s. a week regularly; the father and mother are both drunken, and three children are half starved, and in rags. In another house is a copper ore worker, earning 27s. a week, all of which is spent in drink by himself and his wife. The children are in rags and filth, and look idiotic. In the same street, there are sober men, earning only 20s. and 23s. a week, who are living in comfort.

It is not surprising that our informants, who, as we stated, have the fullest information on the habits of the people, say decidedly "that drink and immorality are the two great causes of the mortality."*

We have, then, a population who are living in houses originally badly planned, and very closely crowded together, and who are placed, partly by their own faults, partly by circumstances, in conditions which necessitate their breathing an atmosphere which is highly fœtid from several causes.

The unhappy people seem to know none of the comforts, and few of the decencies of life, and widespread habits of drunkenness, and consequent want of food, aid their wretched homes in destroying their health.

Add to this, that, in accordance with the usual habits of Irish Catholic population they marry early, being induced by the advice of their priests to do so in preference to living in concubinage.

* We also applied for information to the Liverpool and Birkenhead Temperance Band of Hope Union, and were favoured with a very careful report on the subject. Among other points the Report states, that in an enquiry specially directed to this point, no single instance was met with of a really steady man not being in regular work; that those who are in irregular work complain of the want of societies to which they could subscribe when in work, and thus obtain relief when out of work. But it is added, that many workmen think such societies could not be made to answer, or would be abused if established.

In some of the streets investigated, in answer to our question by this Society, it is stated that at least half the families are in the condition of drink and poverty already described, and that the number of strictly sober families is very small. And we are quite satisfied, from our own enquiries, that in the streets we went through this proportion is really under the mark.

On the subject of intemperance, there is also much evidence given by various witnesses before the Mortality Sub-Committee of 1865, to which we need not do more than refer. But it bears out everything we have asserted.

In spite of the heavy mortality among the children, the proportion of children is therefore not smaller than in other populations, and so, year after year, there goes on an immense production, and as great destruction, of human life.

When, from the houses, we pass to the condition of the courts outside, it is impossible not to be struck with the contrast. Here the work of the Corporation is seen at once. Most of the courts are well paved; many have stand-pipes for the supply of water (and which at the time of our visit was always on); and galvanised iron receptacles, in which all the dry rubbish of the house is put, are placed in convenient situations. Almost every court is well drained. On laying bare, and opening two court drains selected by ourselves, we found that they were in perfect order, and that their channels were clear and entirely free from deposit.

In many courts, walls, buildings, and even whole houses, have been removed during the last few years for the admission of light and air, and in this way a work of sanitary amelioration has been accomplished by the Corporation, with the magnitude and importance of which, we cannot refrain from remarking, that we were very strongly impressed. Still, of course, the essential features of the labyrinth of courts remain, and can only be removed by demolition on a much larger scale.

Middens have now been practically abolished throughout the greater part of Liverpool. In all of the courts of which we have been speaking, trough water-closets have been constructed in their place.

As these trough closets have been the subject of much discussion, we have made careful enquiry as to their actual condition and working.

As an apparatus for the speedy and safe discharge of large quantities of excreta into a drain, we regard the trough closet as superior to any other with which we are acquainted. So long as the trough is full of water, the solid matters which fall into it are completely covered, and are flooded away into the sewer at the moment that the trough is discharged, as we ascertained by personal observation, in the most efficient and complete manner. Obstructive objects of an improper kind, introduced by carelessness or mischievous design, are easily removed by the scavengers in charge, so that, blockage of court drains is an uncommon occurrence. The troughs are of extremely simple construction, not easily deranged, and can be worked at a comparatively small expense; for all which reasons they are better adapted for a population such as that of the Liverpool courts than any other form of water latrine.

In turning our attention from the troughs themselves to the woodwork covering them, we met with the same contrast already noticed, as existing between the interiors of the houses and the drainage. It is sufficient to say, that the seats were, as a rule, in a state of disgusting filthiness. This was attributed partly to the loss or absence of the keys which had originally been provided, but principally to the habits of the people, with reference to which it may be noted, that a practice prevails pretty extensively, which, in itself is sufficient to account for all that we observed. It appears, that the adults, both male and female, often use the seat by standing on it. On enquiry, we were told that they do this from fear of infection. Whatever may be the real foundation for the fear, the existence of the custom affords evidence of the widely spread fear of venereal diseases which exists among the lowest classes.

In many courts, we observed that the evidences of the negligent dirty habit to which we have referred, extended not only to the closets, but to the pavement. Much is done to counteract this by the vigilance of the officers of the Corporation, but at best inspection can do little, as opposed to the barbarous habits of a half civilized race. We presume that the evil must remain unremedied, until either the people are better instructed, or can be made personally answerable for their neglect.

We determined the effect on the house drains, of the process of discharging the troughs; in the courts in which we opened the drain, it was seen that, though during discharge, the flow was rapid, the quantity flowing at any moment was never sufficient to fill the drain-pipe, so that it could not act as a piston. In the cellars in this and in other courts, when the taps were in order, we could not detect that any air was forced back through the traps, when the trough closet was emptied. In those cellars where the traps were deficient or ineffective, the emptying of the trough closet caused an inconsiderable draught, which was chiefly from the cellar into the drain. In some cases it was at times reversed, but the inflow seemed always greater than the outflow.

In addition to the advantages possessed by trough water closets as arrangements for those courts, in which it would be manifestly impossible to provide a separate convenience for every dwelling, we would refer to another point in connection with the trough closets, to which we are inclined to attach considerable importance. In the presence of an epidemic, either of enteric fever or cholera in a court, it will be easy to put disinfectants into the trough water closets, and thus to destroy the noxious power of the discharges before they

enter the sewers. We strongly advise that this should be done, in case cholera should again visit us.

With respect to the water supply of these courts, the pipes were always full during our visits, but we believe that, for a certain number of hours daily, the supply is cut off; we observed that there was much waste, many of the taps were dripping or were allowed to run. As the supply is not really constant, the people collected it in vessels, and kept it in their rooms or cellars. This is a point, however, on which we need not enlarge, as we believe everything is being done that can be in this direction.

It seemed to us impossible but that the people should gradually become more cleanly, with water thus brought to the very threshold, or into every house.

We have already alluded to the necessity of taking the water tap out of the cellars; when it is put there, it necessitates a drain to carry off the water, and then the house may receive sewer air through a broken trap. It would be much better to have the taps always outside, and if stand pipes, and contrivances for preventing the waste of water were used, it is possible that the waste might be greatly lessened, and enough water be found to give a supply which is constant in the true sense of the word.

If we now bring into comparison the facts before ascertained, as to the nature of the diseases which from year to year yield the high mortality in the selected streets, and the conditions under which we find the people living, we do not conceive that much mystery can remain as to the causes of the high death rate. It is no wonder that the contagious diseases spread in such a closely packed and foul population, and in houses of such a construction. Nor can the delicate frames of children be expected to withstand the effects of such an atmosphere, and of the deprivation of warmth and food, which the drunken habits of one or both parents bring upon them in so many cases. The industrial habits of all our large cities are well known to militate against the lives of children; and the cotton famine taught Lancashire the lesson, that want of work and of wages may really lessen the mortality of children by preserving to them the mother's care. In Liverpool, this cause no doubt is also acting, but, undoubtedly, the most potent agencies in destroying infant life are the conditions above noted. Hence the significance of the terms "atrophy and debility," which occurs so often in the mortality tables as prevalent causes of death in the first five years of existence.

The increased mortality of persons over five years of age is also easily explained. The conditions which formerly in the army gave rise to an extraordinary fatality from diseases of the lungs, exist in equal intensity in these streets. In the year 1838, the Reporters of the Statistical Returns of the Army discovered that, among the strong infantry soldiers of the guards, lung diseases caused no less than 67·7 per cent. of the total mortality, and after an investigation into the possible causes, they considered that the main factor of this result was the foul atmosphere produced by overcrowding. The gradual removal of this condition has resulted in a corresponding diminution of fatal lung diseases in the army, which is the strongest proof of the correctness of the explanation. No doubt, in the case of the inmates of these Liverpool houses, there are co-operating causes; under-feeding and exposure, the necessary results of intemperance, doubtless play their part, and in some cases, special warehouse and factory work may assist the result. But considering how many of the men in these streets are dockyard labourers, and are often employed in the open air, we cannot but attribute the main result to the condition of their houses.

What exact share the sewer air when it enters houses plays in this direction we cannot tell. No doubt it helps in the result, but we must also admit that the returns for four years of the deaths in the selected streets do not give any striking evidence of the prevalence of diseases, such as enteric fever, or fatal diarrhœa, which are often traced back to the effluvia from sewers.

The following table will show this.

Street.	Population, all ages.	Deaths from enteric fever in 4 years, all ages.	Deaths from diarrhœa in 4 years in persons over 5 years of age.	Deaths from diarrhœa in 4 years in children under 5 years of age.	Deaths from simple continued fever in 4 years, all ages.
Bispham	716	..	..	7	1
Sawney Pope	1016	1	3	12	8
Addison	688	..	..	3	3
Lace	715	1	1	4	12
Henry Edward ..	677	..	..	3	3
Adlington	936	..	..	5	4
	4748	2	4	34	31

In this return of enteric fever and diarrhœa, it is impossible to trace any bad effect of sewer air; but if we suppose that cases of enteric fever were returned as "simple continued fever," then it is found that 4,748 persons gave annually eight deaths. So that, even if these were all cases of enteric fever, the proportion would still be trifling. But 9 of these 31 fatal cases in four years of "simple continued fever" were in young children, and, doubtless, these, and many of the cases in adults, represented several diseases, and not simply enteric fever. We have then no hesitation in saying that, in these six selected streets, the usual diseases which, so to speak, are the test of the presence of sewer air and only inefficient drainage, were present to a very small extent. Without denying some influence to sewer air, we are yet thrown back on the other causes of foulness of the air in the houses to principally account for the high mortality from lung diseases, and these causes are, in our opinion, quite sufficient.*

To push this analysis further is unnecessary. We have now examined the most authentic statements we could procure of the diseases causing the mortality in non-epidemic years, and we have had no difficulty in accounting for the excess of deaths. We can perceive no flaw or ambiguity in the results, nor have we the slightest hesitation in expressing our belief that these six streets represent fairly the condition of the numerous streets which more or less closely resemble them.

RECAPITULATION OF THE CAUSES OF THE MORTALITY IN LIVERPOOL.

1. The death rate of Liverpool may be divided into the extraordinary and the ordinary.

2. The extraordinary death rate prevails in those years in which there is an unusual spread of certain epidemic diseases, viz.—Typhus, Small-pox, Cholera, Relapsing Fever, &c.; and, among children, Scarlet Fever and Measles. Enteric fever does not appear to be very prevalent in Liverpool, and has not assumed the proportions of an epidemic for several years.

* This result shows that the condition of affairs in Liverpool in this direction must have very much altered since Dr. Duncan wrote his important essay (on the Physical causes of the high rate of mortality in Liverpool, by W. H. Duncan, M.D., First Report of the Health of Towns Commission, 1844, p. 122). His remarks on fever chiefly refer to Typhus exanthematicus, which was not at that time distinguished in the returns from enteric fever, and is not closely connected with sewage. But making allowances for the better distinction of diseases which can now be made, there is no doubt that enteric fever must have then prevailed more commonly. We infer, therefore, that the improved sewerage has done good in this direction.

In reference to Dr. Duncan's Reports, and others, we cannot help remarking how little the lessons experience taught, and in how small a degree the advice of the Physicians of the town in 1802, on the construction of streets and courts, influenced the authorities.

Owing to the position and trade of Liverpool, there is always danger of the introduction of these diseases when they are prevailing elsewhere. It is therefore necessary to adopt measures, as far as can be done, for isolating emigrants from the stationary population, and for removing, as early as possible, persons affected with any of the above diseases from among the population, either fixed or migratory. Hospitals for these epidemic diseases should be always ready, and the measures now adopted for disinfection of clothing and houses should be energetically carried out and extended. It may be considered certain that Cholera, Typhus, or Relapsing Fever, or any other disease capable of being carried by human beings, will almost certainly be introduced into Liverpool, if it prevails epidemically in North and North-Western Europe, or in Ireland.

3. The ordinary mortality, *i.e.*, of the years without widespread epidemic diseases, may be considered as regards,—

(*a.*) Persons under five years of age.

(*b.*) Persons over five years of age.

In the former case, the mortality is chiefly referrible to five classes of diseases, two, if not three, of which indicate with certainty that the conditions in which the children are placed are in the highest degree unfavourable to them, and are so in consequence, chiefly, of the improper management of the parents. Exposure to cold, improper and insufficient food, and the breathing of highly impure air, are evidently the main causes of the mortality, and arise from the ignorance, neglect, and, in many cases, drunkenness of the parents.

The excessive mortality in persons over five years of age is not owing, in ordinary years, to the widespread prevalence of the zymotic diseases, but is mainly caused by diseases of the lungs, which proceed, doubtless, from several co-operating causes, among which must be placed in the first rank the foul atmosphere of the houses in which so many of the labouring class of Liverpool live. Insufficient clothing and scanty food—the result, in many cases, of intemperance, or of irregular employment—are doubtless powerful aiding causes. The statistical returns of four years from six selected streets, with a gross population of 4,748 souls, do not show any decided evidence of improper sanitary conditions of either water supply or sewerage; but the entrance of sewer air into many of the houses is quite certain, and must contribute to the fœtor and unwholesomeness of the atmosphere, which is the main sanitary defect in the poor houses of Liverpool.

The remedies are to be sought, first, in the introduction of greater volumes of pure air among the crowded quarters, and into the houses of Liverpool; and, secondly and chiefly, in the improvement of the morals of the people, and in the cultivation of habits of temperance, self-restraint, and forethought. The improvement of the ventilation of the houses in Liverpool is a comparatively easy task; but the restraint of intemperance, and the regulation of labour, are matters which will tax to the utmost the skill and determination of the people of Liverpool.

GENERAL STATEMENT OF PROPOSED MEASURES.

For the amendment of the moral and physical evils which the existence of a degraded population in her very midst entails upon Liverpool, the powers of the local authority are at present limited to the abatement of overcrowding; the carrying out of certain constructive improvements; and to enforcing on owners the maintenance of their houses in a state of sanitary repair and cleanliness. Work of this kind has been already so efficiently carried out, under the advice of your present Medical Officer, and his predecessor, the late Dr. Duncan, that we do not desire to suggest any new course of action in this direction. We desire to record our strong conviction that these measures ought to be energetically prosecuted; and, in particular, that the clearances which have been so judiciously made, under the provisions of the Local Sanitary Act of 1864, should be still further carried out.

But we must not conceal our belief that, to make Liverpool as healthy as it ought to be, larger measures are required. No one can look at a map of Liverpool, or calculate the density of the population,* without being convinced that, in some way, surface overcrowding should be lessened. In other words, there should be effected some displacement of the population.

In stating this principle, we have perhaps gone as far as we can, for it must be for the Corporation to determine in what way it should be carried out. So many circumstances of public convenience, expense, and possibility of obtaining powers must influence the decision that we fear to embarrass the Corporation by attempting to give any definite recommendations. We will, however, say a few words, for the purpose of defining our meaning, and of showing how some displacement of the population may, we believe, be effected.

* Thus, Dr. Trench's estimate is, that there are 99·3 persons per acre in Liverpool, and only 41·2 in London, 36·6 in Bristol, 42·7 in Hull, and 80·8 in Glasgow.

But, of course, in special parts of the town, the crowding is far greater, as in our selected streets, where nearly 1,000 persons dwell on one acre.

It is impossible for the Corporation to provide houses for its poor citizens. That would be simply offering a premium to pauperism. But it appears to us that great aid would be given to those who can provide houses* by two measures, which may properly be carried out by the municipal authorities.

The first step for the improvement of the wretched houses of Liverpool must be the bringing pure air into the midst of the crowded quarters. This can only be done by opening wide and straight streets in such directions, and to such an extent as may be determined after consideration of all the circumstances. If gradually carried out, this would displace the population from some part of the worst quarters, and would prepare the way for improvement of the houses that remain.

The second step would be an adjunct to this. As the object is to spread the population over a wider area, some of the workmen will be at a greater distance from their work than at present. This must be met by facilitating means of transport, by which the difficulties of distance are removed. The conditions of urban and suburban life have been totally altered, in the life time of the present generation, by the use of railways, tramways, river and road steamers. Advantage should be taken of these agencies for sanitary work.

If improved means of transport can be combined with the formation of new streets, so as to let the workmen be practically as near his work as he was previously, the inconvenience inflicted on those who are obliged to move would be moderate and transient, while the benefit to all would be great and permanent†.

With regard to the expense of such improvements (which, of course, would be gradually carried out), we may safely say that no expense can be so heavy as that produced by a constant yearly mortality so great as that which prevails in Liverpool. It is certain that sickness is the most costly of all things, and on this ground alone we advocate this proposal. But we would advocate it on higher grounds than its ultimate money advantage. It is incumbent on its

* "We are glad to find that there is a movement on foot in Liverpool (in which your Medical Officer of Health has taken an active interest), the aim of which is to alter the condition of the labouring classes in Liverpool, by improving their home arrangements. It is proposed to do this by two methods: by the erection of blocks of model houses for families, and by purchasing property in the worst districts of Liverpool at a fair but moderate price, effecting a few structural alterations, and placing the houses in good and serviceable repair. We think the latter of these two proposals to be of as great sanitary importance as the former.

† This displacement of the population, from the densely crowded parts of the town, was advocated many years ago by Dr. Rumsey, of Cheltenham, and appears to us to be the true remedy for the condition of the people in many of our large cities.

authorities to remove from Liverpool the great opprobrium of being the most unhealthy town in England; and surely some sacrifice, if needed, will be made to secure to the poorer citizens, as far as public action can do it, the inestimable blessing of health.

In recommending the construction of new streets, we are well aware that the powers actually vested in the Corporation are inadequate for the purpose. It would be necessary to obtain powers from Parliament, in the same manner as for any other public object. It should be distinctly understood, that, although the alterations we contemplate would no doubt be advantageous in many other respects, the end for which we recommend them is exclusively for the improvement of the public health; and the Corporation, in disposing of the land purchased, should be guided entirely by sanitary considerations. We would recommend, for example, that any land which the Corporation might have to dispose of should not be used for the erection of lofty buildings, such as large warehouses, which, by obstructing the free circulation of air, would rather hinder than promote one of the main objects in view; but exclusively for the construction of dwelling houses for the working classes; and the conditions of disposal should be of such a nature as to ensure—

(1.) That the houses should be constructed under the immediate supervision of the officers of the Corporation, as regards drainage, ventilation, and general plan; and

(2.) That they should be maintained in sanitary repair, under strict regulations.

By this scheme, and by persevering with the measures in force, a great improvement would in a few years take place in the ventilation of the houses in the crowded quarters; and we are confident that there would be a commensurate and material improvement in the health of those living in them.

After this great sanitary measure has been maturely considered and set in movement, there remains, perhaps, the most difficult question of all, How can a disorderly and drunken people be made to understand the injury that they inflict on themselves, on those dependent on them, and indirectly on all living near them? How can drunkenness be lessened, labour regulated, and habits of care and forethought made to take the place of the reckless and barbarous life which runs through a brief career in the crowded courts of Liverpool.

With such habits and such a reckless disregard of the commonest rules of health, it would be marvellous indeed if the death rate were not high.

It is not for us to discuss remedies for evils, which the sagacious men who govern the city of Liverpool are far more competent to deal with than we are. We are not bringing to their notice for the first time the amount of drunkenness and consequent destitution which exists. These things are but too familiar to them, and some of the Town Council may perhaps think we have not drawn the picture in lines deep and sombre enough to express the reality. We will not presume to indicate the remedy for these evils, but we will venture to say, that we think it impossible that those great employers of labour who show such remarkable talents for organization and administration, should not be able to deal also with the problem of the foul social life which many of those who labour for them are leading.

Surely, if a combination of masters were ever justifiable, it would be in this case. The regulation of intemperance and of labour can, after all, present no insuperable difficulty, if the existence of the evils we have noted has been fully realised. The difficulty arises from the opposition of those who do not believe what is stated, or who believe improvement to be impossible, and are content to let things take their own course. To any such persons we would suggest that, in a question of such vast importance as this, they should not rest satisfied with simply denying or ignoring the existence of the excessive vice and destitution of parts of the town. They should examine for themselves; and we have then no doubt they will not fail to recognise a state of things, which if not righted, will eventually, in some way or other, right itself, perhaps at the expense of the whole community.

from the auth.

REPORT ON THE SANITARY STATE OF ST. MARY'S HOSPITAL, PADDINGTON,

WITH REFERENCE TO THE PROPOSED IMPROVEMENTS AND REPAIRS.

HAVING in accordance with the request of the Committee, visited the Wards and other parts of the building, and having had the proposed changes and improvements explained to me by the Secretary, Mr. Wilkinson, and the Architect, Mr. Salter, I beg to report as follows :—

The Hospital is radically bad, in its position, surroundings, plan and details; and there is no doubt that, if it were possible, it would be better to abandon it and build another under improved sanitary conditions. As it appears, however, that such a course is for the present impossible, the next best thing is, to consider how far the existing building can be improved so as to benefit the inmates to the utmost.

The fundamental principles that ought to guide us in the construction of Hospital Wards, are these :—

1st.—Each Ward should be as far as possible isolated from the rest of the building, and should have no direct communication with any other Ward, or even with a lobby or corridor, except by the entrance door, which ought to be kept shut as much as possible.

2nd.—There ought to be means of cross ventilation, that is, air ought to be admitted from both sides of the Ward.

3rd.—The Ward ought to be free, as far as can be, from all projections and irregularities of outline likely to interfere with free circulation of air.

4th.—There ought to be a minimum of floor space for each patient, as follows :—

For Ordinary Cases : Not less than 100 square feet per head.
For Surgical Cases, or Infectious Cases. } Not less than 120 square feet per head.

These numbers ought to be the absolute minimum, and more space ought to be supplied if possible.

5th.—Nothing above 12 feet in height ought to be reckoned as *effective cubic space*; this would give :—

For Ordinary Cases . . . 1200 cubic feet of space per head.
„ Surgical or Infectious Cases 1440 „ „

Lofty Wards are objectionable, as increasing the difficulties of ventilation and warming.

6th.—The floor and cubic space ought to be *net*, after making all deductions for irregularities of shape of Ward, projections and bulky articles of furniture.

7th.—The air ought to be changed at the rate of not less than 4000 cubic feet per head per hour, for ordinary cases, and as much more as could possibly be given (without too great lowering of temperature) for surgical and infectious cases.

8th.—There ought to be a certain amount of inlet and outlet opening per head, the total sectional area of which ought not to be less than 60 square inches, and this might be supplied partly by the windows, partly by the chimneys, and partly by special openings. It is, however, unadvisable to allow the windows to reckon for more than *one third* of this, so that in cold weather ventilation might still go on even if the windows were closed.

9th.—The temperature of the Ward ought not to be below 63° F., and, if possible, not above 65° F., and there ought to be a difference of not less than 4 ° F., and not more than 5 ° F., between the wet and dry bulb thermometers.

10th.—All sinks, water closets, and the like, ought to be removed entirely out of the Ward, and placed in an annexe externally, communicating with the Ward by means of a lobby having free cross ventilation.

11th.—Everything that favours accumulation of dust, or absorption of organic matter, ought to be avoided; therefore the

oiling or varnishing of the floors, and the painting or varnishing of the walls and ceilings, so as to admit of their being washed, are advisable.

12th.—There ought to be means of flushing the whole building and every part of it with air as often as seems necessary.

13th.—Care should be taken that the air actually supplied is *pure*, and not exposed to contaminations from dust bins, privies, or other sources of impurity.

In applying those principles in the present case, I would recommend the following :—

1. All communications between one Ward and another, or between Wards and lobbies, corridors or other rooms, by windows or wall openings, ought to be securely built up with brick and mortar.

2. Ventilation tubes and Sheringham valves ought to be introduced into the Wards, as proposed by Mr. Salter ; but they ought to be much more numerous than contemplated in the plans. Tubes ought also to be introduced from opposite sides of the building, so that ventilation may be secured whichever way the wind blows.

3. All projections and irregularities of outline ought to be got rid of, as provided in Mr. Salter's plans.

4. The surgical and infectious cases ought to have a net minimum of 120 square feet of floor space ; all others at least 100.

5 & 6. The Wards are lofty enough to secure the minimum of cubic space, if the floor space be secured.

7 & 8. To secure the change of air necessary, each patient ought to have 60 square inches of sectional area of ventilation-opening, of which at least 40 ought to be independent of windows. The upper floors ought to have a larger amount, according to height, so that if the ground floor be taken as unity, the others ought to have as follows :—

Ground Floor. $60 \times \frac{7}{7} = 60$	Second Floor. $60 \times \frac{7}{5} = 84$.
First Floor . $60 \times \frac{7}{6} = 70$.	Third Floor . $60 \times \frac{7}{4} = 105$.

9. To provide the proposed temperature (63° F. to 65° F.), it may be necessary to employ additional means of warming if the present fireplaces seem insufficient.

10. The removal of sinks and water-closets is provided for in Mr. Salter's plan, and where these are still left necessarily in proximity to the Ward, they may be improved by opening additional windows; and the insertion of ventilators.

11. I would commend to consideration the oiling or varnishing of the floors, and the painting and varnishing of the walls and ceilings.

12. In Mr. Salter's plans arrangements are made for opening out additional windows, and introducing ventilators into the corridors or lobbies, so as to flush the building with air.

13. An important improvement is also suggested in the position of the dust-bin, which ought to be emptied daily if possible, but not less than three times a week.

The proposed arrangements for the improvement of the Out-Patients' Department appear to be as good as circumstances will allow.

With regard to the Accident Ward, in which a screen divides the Ward, I would recommend the entire removal of the screen. It has been already observed, I am told, that the cases lying near the screen do not do so well as those near the windows. If, however, it is insisted that it shall remain, it ought to be lowered to 4 feet, and openings made to allow of a free circulation of air under the beds. Ventilation tubes ought to be introduced alongside the pillars, so that the patients in the middle of the Ward may have the advantage of air coming to them directly without passing over other patients.

In conclusion, I would request the Committee to consider this Report as preliminary, as I propose to make some experiments while the Hospital is in actual occupation, and to present the results in a subsequent report.

F. DE CHAUMONT, M.D., *Surgeon-Major*,

Conjoint Professor of Hygiene, Army Medical School.

June 29th, 1875.

SECOND REPORT

ON

ST. MARY'S HOSPITAL, W.

ON the 2nd of July, 1875, experiments were commenced in the Hospital for the purpose of ascertaining the condition of the atmosphere under the existing circumstances. They were continued over the 3rd and 4th, and were directed to the following objects:—

1.—To ascertain the condition of the External Air as regarded— Barometric Pressure;
Temperature;
Hygrometric conditions;
Carbonic Acid;
Organic Matter;
Suspended Matter;

2.—To ascertain the same in some of the Wards. For this purpose the Secretary pointed out to me certain Wards which were generally thought "Bad," and certain others usually considered "Good." Of the former, viz., "Bad," there were selected:—

"Victoria," Female Medical, First Floor.

"Thistlethwayte," Male Surgical, Second Floor.

Of the latter, viz., "Good," there were selected:—

"Cambridge," Male Medical, First Floor.

"Manvers," Female Surgical, Second Floor.

In addition to these, I thought it important to examine also the "Accident" Ward, particularly with reference to the effect of the wooden screen which divides the Ward into two parts. "Foresters" Ward was also partially examined.

N.B.—This was done with Casella's Air Meter. The Velocity is stated in linear feet per minute. + Means incoming. − Means outgoing currents.

In addition to the chemical and other points already mentioned, I also examined the rates of velocity of the air-currents at the ventilators, windows, chimneys, &c., as far as time permitted.

In the Wards, the samples of air for Carbonic Acid were collected between 11-30 p.m. on the night of the 2nd, and 2 a.m. on the morning of the 3rd, a time that would probably give a fair idea of the average condition of the Wards.

The samples for Organic and suspended matter were collected during the day and night of the 3rd.

The examination of the velocity of the air-currents was made during the day of the 4th.

In the External air the samples for Carbonic Acid were collected on the night of the 2nd, the day and night of the 3rd, and the evening of the 4th.

All the Carbonic Acid determinations are reduced to a standard of 0° Centigrade, and 760 millimètres pressure.

In determining the Organic matter, the washings of the air were analysed in several ways :—

1. By the permanganate process, showing the amount of Oxygen required for the oxidisable matter.
2. By the ammonia processes, showing the amount of Free Ammonia, and the amount of Potential or Albuminoid Ammonia.

   *** In these processes the results are stated as milligrammes per cubic mètre.
3. By the microscope, to determine the nature of the suspended matter.

   This part of the inquiry was most kindly undertaken by my colleague, Dr. J. D. Macdonald, R.N., F.R.S., whose excellent drawings accompany this Report.

A tabular summary of the results is also appended.

EXTERNAL AIR.

Carbonic Acid

On the night of the 2nd, the air was very still and nearly saturated with moisture. This prevented rapid diffusion, and probably led to retention of Carbonic Acid and Organic impurities in the lower strata of the atmosphere. Accordingly the mean of four samples of air taken in the garden of the Hospital gave 0·823 per

1000 volumes of Carbonic Acid, the normal ratio being 0·400 to 0·450 even in London streets. During the day-time of the 3rd instant, there was more rapid movement of air, and the mean of three samples gave 0·534; still high, but much below the previous night. On the night of the 3rd, *twelve* samples were collected in the neighbouring streets, namely :—

Three in Cambridge Place;
" " Praed Street;
" " Stanley Street;
" " Wharf Road.

Those gave for a mean 0·568 per 1000.

As those, however, were all on the ground level, and as the wards would, for the most part, get their air from higher strata, I had twelve other samples collected on the roof of the Hospital on the evening of the 4th inst. Those gave for a mean 0·471 per 1000, more nearly approaching the usual amount. For comparison with the air in the wards, I have adopted the mean of all the 31 external experiments, namely, 0·560 per 1000 of Carbonic Acid.

Oxygen.

The air washings for organic matter were collected by means of aspirators in the garden, on the day and night of the 3rd. The amount of Oxygen required to oxidise the oxidisable matter of one cubic mètre of air was 1·43 milligrammes, *a very large amount.*

Free Ammonia.

The Free Ammonia was 0·3574 per cubic mètre, also *a very large amount.*

Albuminoid Ammonia.

The Potential or Albuminoid Ammonia, which indicates the presence of putrescible nitrogenous matter, was 0·5280 per cubic mèter, *an amount as great as was found by Dr. Angus Smith in the air over a midden.*

Suspended Matter.

For a detailed account of the suspended matter, see the Supplementary Report with the drawings.

On the night of the 2nd, when the Carbonic Acid experiments were made, the Barometer (corrected and reduced to mean sea-level) read 29·700 inches; Temperature 58°5 F.; Direction of the Wind S.W. and very slight. The air was nearly saturated, the humidity being 97 per cent.

WARDS.

'Victoria.'

Space, &c.

1.—"Victoria," First Floor, Female Medical, containing 15 beds, all occupied; floor-space per bed, 115 square feet.

Total cubic space per bed, 2077 cubic feet.

Height of Ward, 18 feet.

Nett *effective* cubic space per bed, limiting the height to 12 feet, 1400 cubic feet.

This Ward smelt close on entering it, particularly in the corner by the door. Several of the windows were open, however, and there was a good draught up the chimneys.

The Temperature was 65° 0 F.; and the Humidity 83 per cent.

Carbonic Acid

The mean Carbonic Acid of four samples was 1·020 per 1000 vols., whilst in the corner near the door it was 1·534. Taking the outer air at 0·560, the mean gives an excess of 0·460 per 1000 (or 0·00046 per cubic foot) due to Respiratory Impurity. Assuming that each inmate gives off at least 0·6 of a cubic foot (= 0·0172 cubic mètre) of Carbonic Acid per hour, we find the amount of air supplied and *utilised* per head to be as follows:

$$\frac{0{\cdot}6}{0{\cdot}00046} = 1310 \text{ cubic feet per hour.}$$

But with several windows open, a good draught in the chimneys, &c., a much larger quantity of air must have passed into the Ward, although in most cases it must have passed out again without becoming available for ventilation purposes. Thus the chimneys alone must have carried off about 15000 cubic feet per hour, the rate of velocity being 250 linear feet per minute, when tested on the 4th instant. At the same time air was passing out by the Scullery window at the rate of 500 linear feet per minute, and coming in at the Ward windows at above 100 feet per minute. Allowing for the fact that the night was a still one, there could not be less than 3000 cubic feet per head per hour supplied, of which more than *one half* was wasted, as only 1310 proved to be effective. As each patient has 2077

Velocities of Air Currents.

cubic feet of space it follows that the air was changed *effectively* only 0·64 times per hour, or about $15\frac{1}{2}$ times in 24 hours, instead of 48 times as it ought to be for the minimum of good ventilation.

In this Ward the air was drawn through a condensing tube to collect the suspended matter; for which see Supplement.

The Oxygen and Ammonias were not determined.

"Cambridge."

Space, &c.

2.—"Cambridge," First Floor, Male Medical; 10 beds, all full; floor space per bed, 137 square feet.

Total cubic space, 2470 cubic feet per bed.

Height of Ward, 18 feet.

Nett *effective* cubic space per bed, limiting height to 12 feet, 1647 cubic feet.

There was no unpleasant smell in this Ward.

The Temperature was 67° 0, and the Humidity 85 per cent.

Carbonic Acid

Four samples of air gave a mean 0·749 Carbonic Acid per 1000 volumes, which shows an excess over the outer air of 0·189 per 1000, (or 0·000189 per foot), due to Respiratory Impurity.

From this we find the amount of air supplied and *utilised* per head to be:

$$\frac{0{\cdot}6}{0{\cdot}000189} = 3170 \text{ cubic feet}$$

per hour, the largest amount as a mean of a *Ward* found during the whole inquiry.

Velocities.

On examining the Air Currents, on the 4th inst., we found—

No movement in the wall openings to Albert Ward.

In the opening over Medical Officers' Room, a variable but strong out-going current.

At the Scullery window, + 395 per minute.

At the door leading to Scullery and Water Closet, + 55 per minute.

Chimneys (fire lighted), —338 per minute.

More of the air was utilized in this Ward than in any other; but still much must have been lost. In this case, as in several others, *there was a strong indraught from the Water Closet.*

Organic Matter.

The Organic matter was determined in the same way as in the outer air, with the following results;

Oxygen required for the oxidisable matter of one cubic mètre, 1·49 milligrammes,—*a slight increase over the outer air.*

Free Ammonia, 0·66·0 milligrammes per cubic mètre,—*about 90 per cent. above the outer air.*

Albuminoid Ammonia, 0·4710 milligrammes per cubic mètre,—*a little under the outer air.*

For the Suspended Matter, see Supplementary Report.

"Manvers." 3.—"Manvers," second floor, female surgical; 13 beds, all occupied; floor space, 132 square feet per bed.

Space, &c. Total cubic space, 2383 cubic feet per bed.

Height of Ward, 18 feet.

Net *effective* cubic space, limiting the height to 12 feet, 1590 cubic feet per bed.

This Ward smelt a little close; but not so much so as "Victoria." Several windows were open, and there was a fair movement of air. Temperature 68 ° F.; Humidity 78 per cent.

Carbonic Acid. Mean Carbonic Acid of four samples of air, 0·855 per 1000, one sample being as much as 1·007. The mean showed an excess of 0·295 per 1000, (or 0·000295 per foot,) due to Respiratory Impurity. From this we find the amount of air per head supplied and *utilized* per hour to be as follows:

$$\frac{0{\cdot}6}{0{\cdot}000295} = 2030 \text{ cubic feet.}$$

The air was thus *effectively* changed 0·87 times an hour, or 21 times in 24 hours, instead of 48 times, as it ought to have been.

Velocities. When the velocities of the air currents were determined on the 4th, the following were noted:

Ventilators in the wall. { Near the floor—155 ft. linear per min.
Above the beds—120 „ „

Sometimes, however, the currents ceased altogether.

Louvred Ventilator over fireplace, + 86 per minute.

Large grate opposite windows, — 338 per minute.

Smaller grate on window side (lighted) — 243 linear feet per minute.

Doorway to Scullery and Closet *variable*.

Doorway at Sink . . . . — 59 linear feet per min.

Centre door of Ward to back staircase — 96 „

Windows of Ward (several opened + 332 „

There was therefore, a large movement of air going on, but a great deal of it simply passed through the Ward without being *utilised* At one time at least 12,000 to 13,000 cubic feet per head per hour must have been supplied; but such a current could only be stood in warm weather. At night, with several of the windows open, probably 3000 cubic feet were supplied, *of which quite one third was wasted.*

In this Ward the suspended matter was collected in a condensing tube, for which see Supplementary Report.

The Oxygen and Ammonias were not determined.

"Thistlethwayte." 4.—"Thistlethwayte," Second Floor, Male Surgical; 16 beds, of which 12 were occupied; floor space per bed 112 square feet.

Space, &c. Total cubic space per bed, 2027 cubic feet.

Height of Ward, 18 feet.

Net *effective* space per bed, limiting height to 12 feet, 1360 cubic feet.

This Ward had a slight smell of closeness.

Temperature 69 ° 5 F.; Humidity 75 per cent.

Carbonic Acid. Mean carbonic Acid of four samples of air, 0·817 per 1000 vols. This argues a Respiratory Impurity of 0·000258 per cubic foot, or 0·258 per 1000. Calculating from this the air supplied and *utilised* per head, we find —

$$\frac{0{\cdot}6}{0{\cdot}000258} = 2330 \text{ cubic feet per hour.}$$

The air was *effectively* changed 1·18 per hour, or about 28½ times in the 24 hours, instead of 48 times in that period as it ought to have been. The amount actually utilised was probably about two-thirds of the air supplied at night; but during the day a much larger quantity (badly distributed) was sweeping through the Ward. It is to be noted, that this Ward was only three parts full, so that if the full complement of patients had been occupying it, the air would have been in a worse state, and the amount of fresh air actually utilised probably only 1800 cubic feet per head per hour.

Organic Matter. The Organic matter was examined in the same way as in the outer air, with the following results:—

Oxygen required for the oxidisable matter of one cubic mètre, 1·51 milligrammes; above the ratios of both the external air and "Cambridge."

Free Amonia, 0·6469 milligrammes per cubic mètre; about 80 per cent. above the outer air, but a little below "Cambridge."

Albuminoid Ammonia, 0·4770 milligrammes per cubic mètre; a little below the outer air, but a little above "Cambridge."

For the Suspended Matter, see Supplementary Report.

"Accident." 5.—"Accident" Ward, Male, Ground Floor; 18 beds, all occupied; floor space per bed 111 square feet.

Space, &c. Total cubic space per bed, 2164 cubic feet.

Height of Ward, 19 feet 6 inches.

Nett *effective* cubic space, limiting the height to 12 feet, 1340 cubic feet per bed.

This Ward smelt close on entering it; there was a large fire in the north side of it, and a number of clothes were airing before it.

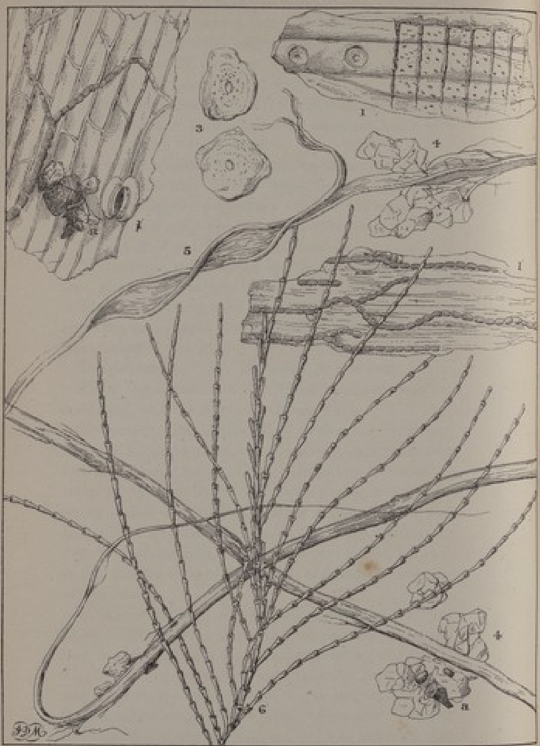
Temperature 69° F.; Humidity 68 per cent.

From the direction of the Wind the *South* was the windward, and the *North* the leeward side.

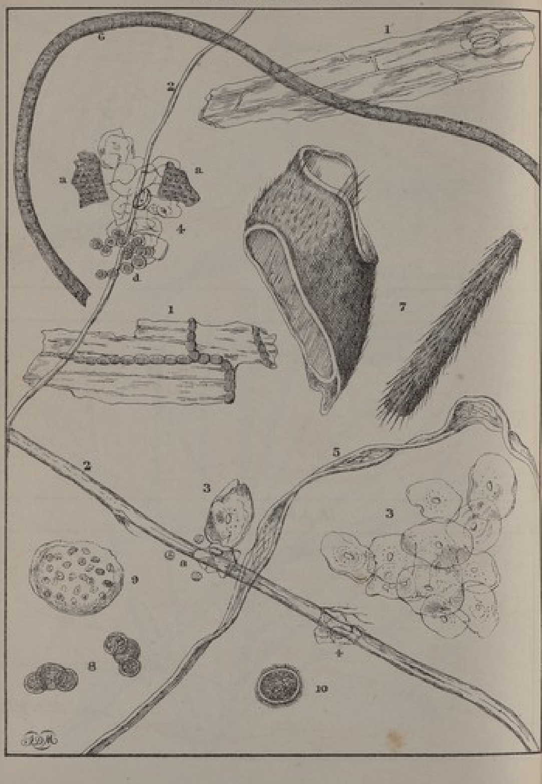
Construction. The construction of the Ward is peculiar; it is very wide, 52 feet, and there are windows down each side, and ventilators near the floor. Down the centre of the room, at right angles to the entrance door, is a wooden screen, 8 feet high, with a folding flange at each end, four pillars support the roof, two on each side a few feet from the screen. Five beds are placed on each of the window sides of the Ward, and four on each side of the screen.

It is obvious that all the fresh air obtained by the latter, must pass over the beds at the window sides, and that free circulation must be interrupted by the screen. The Ward door appears to be generally kept open, so that air from the staircase also comes in; and there is also an interchange of air with "Foresters'" Ward, opening off it at the opposite end. I was informed that the health of the patients in the beds by the screen was less good than those at the window sides, and that

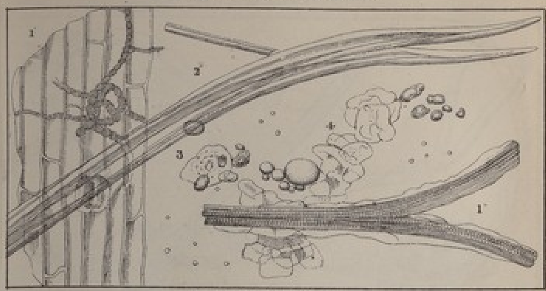
EXTERNAL AIR.



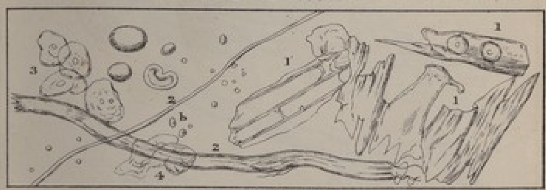
ACCIDENT.



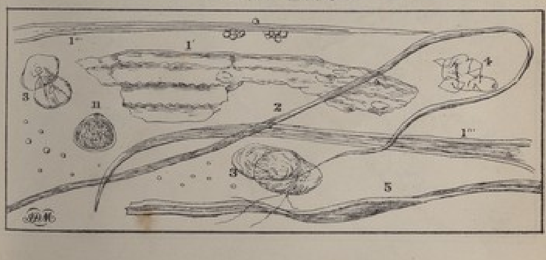
CAMBRIDGE.



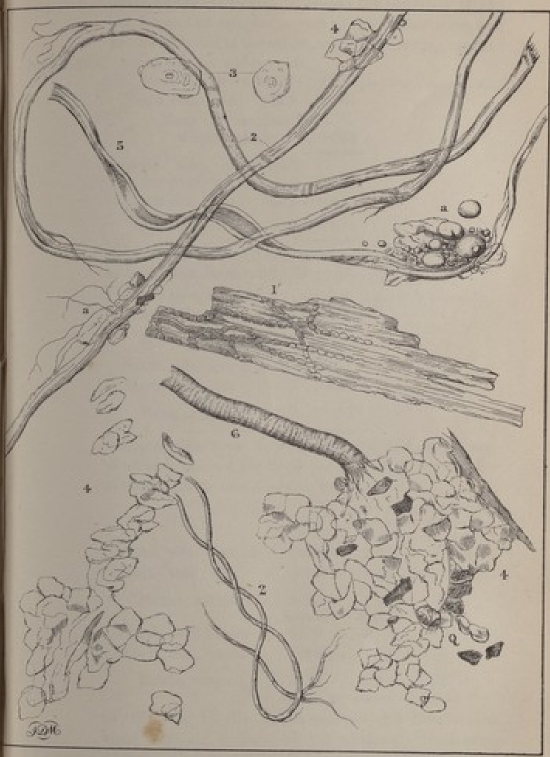
VICTORIA.



MANVERS.



THISTLETHWAYTE.



Erysipelas frequently made its appearance among them. With a view, therefore, of testing the condition of the air, I took two samples on each of the window sides, and two on each side of the screen, with the following results:

Carbonic Acid

South side, on window side, (mean of two samples)	0·726	per 1000 of Carbonic Acid
North side, do. (do.)	0·801	,, ,,
Mean of samples at window sides	0·764	,, ,,
South side, at Screen, (mean of two samples)	0·801	,, ,,
North side, do. (do.)	0·946	,, ,,
Mean of samples at screen	0·874	,, ,,

Reducing these by subtracting the outer air ratio, so as to get the Respiratory Impurity, we find:—

South side, window	0·166	Respiratory Impurity.
North side, do.	0·241	,, ,,
Mean of window sides	0·204	,, ,,
South side, screen	0·242	,, ,,
North side, do.	0 386	,, ,,
Mean of screen	0·314	,, ,,

Calculating from these the amount of fresh air supplied and utilised per head per hour, and the number of times the air was changed, we find:—

	Cubic Feet.	Air Changed effecting Per Hour.	Air Changed effecting In 24 Hours.
South side, window	3620	1 66	41 times.
North side, do.	2500	1·15	28½ ,,
Means, windows	3060	1·41	35 ,,
South side, screen	2480	1·15	28½ ,,
North side, screen	1560	0·72	18 ,,
Means, screen	2020	0·93	23 ,,

Or, the beds by the screen received only *two-thirds* as much fresh air as those by the windows. If we compare the condition of the beds on the windward (south) window side, with those on the leeward (north) screen side, we shall see the great disadvantage in which the latter were placed :—

	Cubic Ft.	
South side, window, (windward)	3620	per head per hour
North side, screen, (leeward) .	1560	,, ,,

Or, the beds on the leeward side of the screen received only 43 per cent. as much air as those on the windward window side of the ward. I cannot but hope that the Committee will here see a strong argument for the total abolition of the screen,—seeing that the beds on the leeward window side suffer as well, the amount of air they receive being just equal to that on the windward side of the screen, in spite of their apparent advantages of position. *Were the screen removed all would benefit by the freer circulation of air.*

The mean general condition of the Ward gave 0·819 per 1000 of Carbonic Acid, equal to 0·259 of Respiratory Impurity,—showing a mean *effective* delivery of fresh air to the extent of 2330 cubic feet per head per hour. The air of the ward was thus changed 1·02 times per hour, or 24½ times in 24 hours, about one half as often as it ought to have been.

As the windows were shut at night the air was partially supplied by the ventilators and partially from the centre hall; but also in considerable part from the Velocities. water closets, from which a strong draught was setting in. The Air Meter observations on the 4th instant showed the following :—

Chimneys, an up-current	— 600	linear feet	per min.
South windows, windward	+ 320	,,	,,
North windows, leeward .	+ 58	,,	,,
Ventilators near floor, south, windward . .	+ 32	,,	,,
Do. do. north, leeward	Nil	,,	,,

Altogether, in the day-time, about 4000 to 5000 cubic feet of air per head per hour must have passed through the Ward; but at night, with the windows shut, a considerably smaller quantity, part at least of which was not *utilised*.

Organic Matter. The Organic and Suspended Matters were collected on the leeward side of the screen, and gave the following results :—

Oxygen required to oxidise the oxidisable matter of one cubic mètre of air, 1·36 milligrammes

This is a little below the outer air, and may perhaps have been due to the comparative dryness of the Ward air at this part.

Free Ammonia, 0·3519 milligrammes per cubic mètre.

This is very near the outer air ratio, which was, however, exceptionally high.

Albuminoid Ammonia, 0·6915 milligrammes per cubic mètre.

This is an enormous quantity, much the largest met with in the whole inquiry, being more than 30 per cent. above the very high outer air ratio. It bears out the Carbonic Acid observations as to the unhealthy condition of the air near the screen, and this is still further corroborated by the microscopic examination, for which see Supplementary Report.

"Foresters." 6.—"Foresters" Ward. This is also a Male Accident Ward, communicating with the former by a permanent opening in the wall, its only means of access. It contains 10 beds, which were all occupied. Floor space, Space, &c. 137 square feet per bed. Total cubic space per bed, 2678 cubic feet.

Height of Ward 19 feet 6 inches.

Nett *effective* cubic space, limiting height to 12 feet, 1620 cubic feet per bed.

The Ward smelt close, and the windows were shut. Temperature, 69° 5 F.; Humidity, 78 per cent.

Carbonic Acid. Mean of two samples of air, 0·855 of Carbonic Acid per 1000, corresponding to a Respiratory Impurity of 0·295, indicating a mean *effective* delivery of 2030 cubic feet of air per head per hour; or the air was changed 0·8 times per hour, or 19 times in 24 hours, instead of the normal minimum, 48 times.

Velocities. On the 4th inst. the air meter shewed an up-current in the chimney of —400 linear feet per minute, there was also an in-draught from the closet of + 132 linear feet per minute.

The Organic and Suspended Matters were not collected in this Ward.

Although it has numerous windows, this Ward has the disadvantage of being over the laundry, from which it receives a good deal of vapour, and most likely Organic Matter as well.

GENERAL MEAN OF THE WARDS EXAMINED.

The following are the means of the observations:—

Temperature, 68° F.
Humidity, 78 per cent.

There was a difference of 9° 5 F. above the outer air, and about 5° F. more than is desirable in a Ward. The Humidity was about 5 per cent. more than may be expected in a well-ventilated ward. This shows an amount of vapour equal to 5·8 grains per cubic foot. To reduce it to 73 per cent. Humidity, (or 5·5 grains per cubic foot), while the external air contained 5·2, we should have required to change the air as follows:—

$$\frac{5{\cdot}8 - 5{\cdot}5}{5{\cdot}5 - 5{\cdot}2} = \frac{0{\cdot}3}{0{\cdot}3} = 1, \text{ or we should have}$$

required to change the whole, at least, once an hour, *in addition* to the actually ascertained delivery. Now the cubic space per bed (mean) is 2256 cubic feet; so that this amount would have been necessary per hour, in addition to the amount by calculation from the Carbonic Acid.

Carbonic Acid

Mean total Carbonic Acid . 0·847 per 1000.
,, Repiratory Impurity . 0·287 ,,
Effective supply of air per head per hour . . . . 2080 cubic feet.

Adding to this the amount required for diluting the vapour as above shown, we have:—

Effective supply calculated from CO_2	2080	cubic feet.
Additional to reduce Humidity . .	2256	,,
Total required . .	4336	,,

This is very close to the amount (4000) which I laid down in my first Report as the desired minimum. Such a supply would reduce the Respiratory Impurity (taken as CO_2) to about 0·140 per 1000, at which point the Wards would be free from all smell.

Organic Matter.

Mean *Oxygen* required for the oxidisable matter of one cubic mètre, 1·4500 milligrammes.
Free Ammonia, 0·5560 milligrammes.
Albuminoid Ammonia, 0·5465 milligrammes.

In every case the amount is higher than the external air, which, collected as it was in the lower strata of the atmosphere, was exceptionally impure.

GREAT STAIRCASE.

Perhaps the best general idea of the condition of the Hospital may be obtained from the air of the Great Staircase, which gave the following results:—

Ground Floor .	0·999	per 1000	of Carbonic Acid.
First Floor . .	0·930	,,	,,
Second Floor .	1·091	,,	,,
Mean .	1·007	,,	,,

This gives of Respiratory Impurity, 0·447 per 1000 of Carbonic Acid, showing an effective delivery of fresh air to each inmate, of 1350 *cubic feet per hour*, or about *one third* only of the necessary amount.

OUT-PATIENTS' PASSAGE.

I intended to have made some observations in the passage where the Out-Patients wait; but the day (Saturday) was an unfortunate one, as there were very few patients.

A sample of the air gave:— 0·706 per 1000 of Carbonic Acid.
Whilst another at the Open

Door gave	0·356	,,	,,
Respiratory Impurity	0·350	,,	,,

Indicating an effective delivery of 1720 cubic feet of air per head per hour.

MICROSCOPICAL OBSERVATIONS.

I propose to present here the Supplementary Report on the Microscopical Characters of the Suspended Matters, previous to making some concluding remarks.

SUPPLEMENTARY REPORT ON THE MICROSCOPICAL CHARACTERS OF THE SUSPENDED MATTER IN THE AIR.

The following is a detailed index of the objects in the drawings, the references being common to all the figures:

1. Fragment of Pine-wood.
1'. Epidermis of Hay, often with Fungus attached.
1''. Fibro-vascular Tissue.
1'''. Hairs, one bearing the Spores of a Fungus.
2. Linen Fibre.
2'. A small Fungus adherent.
2''. Coarse Fibre Cells, as of Jute.
3. Nucleated Epithelial Scales from the Mouth.
3*a*. Pus Cells? (In Accident Ward.)
4. Epithelium detached from the Skin.
4*a*. Charred Vegetable Particles and Mineral Matter.
4*b*. Spores of Fungus.
5. Cotton Fibre.
5*a*. Wheaten Starch.
6. Wool.
6'. Feather, or rather Down.
7. Fragments of Insects.
8. Pine Pollen.
9. Dried-up Palmellaceous Frond.
10. Ciliated Spore, probably of *Voucheria*.
11. Non-ciliated Spore, or Minute Ovum.

In addition to the definite objects figured, there was a large quantity of Molecular or Granular Matter, which is not shown in the drawings, in order to avoid confusing the field.

EXTERNAL AIR.

The substances present were: portions of pinewood, epidermis of hay with a fungus, some down, and cotton and linen fibres entangling epithelium from the human skin; there were also nucleated epithelium scales from the mouth. These last probably came from the Wards themselves.

"Victoria" Ward. In this Ward were visible: pinewood and hay epidermis, linen fibre, epithelium, both from skin and mouth, wheaten starch and spores of mycelusm of fungus, also oil globules.

"Manvers" Ward. Here there were: linen and cotton fibres, hay epidermis, vegetable hairs, epithelium of both kinds, as before, a nonciliated spore or minute ovum, and oil globules.

N.B.—In the above two Wards the Suspended Matter was collected in refrigerating tubes; in all the others the air was carried through distilled water.

"Cambridge" Ward. Here there were: hay epidermis with a fungus, coarse fibres like jute, some fibro-vascular tissue, wheaten starch, epithelium, and oil globules.

"Thistlethwayte" Ward. Here were: hay epidermis with fungus, linen, cotton, and woollen fibres entangling wheaten starch, and skin and mouth epithelium, also the mycelium of a small fungus, besides charred particles of vegetable matter.

"Accident" Ward, (taken near the screen.) This yielded the most copious supply of all; there were: linen, cotton and woollen fibres, pinewood, also some pine pollen, hay epidermis with fungus attached, exuviœ of insects, charred vegetable matter, dried up palmellaceous frond, a ciliated spore, probably of Voucheria, spores of fungus, skin epithelium, cells of nucleated epithelium from the mouth in large quantity, and a few pus cells.

Several of the above facts call for notice. In the first place, the general presence of the epidermis of hay is curious, and I would suggest the probability of its being the remains of dried horse-dung from without.* This is further rendered probable by the fact of portions

* This has since been confirmed by actual comparison with dried horse-dung from the roads.

of material presenting some fœcal characters having been noticed by Dr. Macdonald, although they are not specially figured in the drawings. Another noticeable point is the frequent presence of oil globules in the air of the wards; although it is possible that this might arise from articles of food or dressings, yet there is also reason to think that the globules may come from the skins of the inmates.

The universal presence of epithelium is very suggestive, and its large quantity in the "Accident" Ward, together with the existence of pus, fully bears out the results of the chemical analysis, and confirms the opinion expressed of the unhealthy character of the air in the neighbourhood of the screen.

The following remarks by Dr. Macdonald accompanied his drawings:—

"Inspection of the accompanying figures shows:—

"1.—That materials from within the Hospital find "their way into the outer air, and *vice versa*.

"2.—That a large per centage of the materials "obtained within the Wards consists of epithelium, "detached from both the mucous and cutaneous "surfaces.

"3.—That when bodies so large as the exuviœ of "insects and entomostraca are carried about in the air "under ordinary conditions, it is easy to perceive how "morbific matter may be conveyed from one patient to "another, in floating fibres of linen, cotton and wool, "with epithelium, and even pus itself, by simple cur-"rents of air."

The conclusion to be drawn from all this is simple: viz., that the outer air ought to be pure, and delivered in plenty into the Wards in such a way as to be thoroughly distributed; whilst at the same time every facility for the exit of foul air ought to be given, and every obstruction to such delivery and exit at once removed.

CONCLUDING REMARKS.

I think the foregoing results fully bear out what I stated in my former Report, as to the objectionable character of the Hospital in its surroundings, plan and details. The atmosphere about it, particularly in the lower levels, is contaminated from various sources, among which may be noted; the immediate proximity of other buildings, the steam from the laundry, the position of the dust bin, and the presence of impurities from the Wards themselves, which are but slowly diffused and got rid of on account of the confined condition of the air in the immediate neighbourhood of the Hospital. This is borne out by the exceptionally high amounts of Carbonic Acid and Organic Matter, as well as by the presence of such suspended matter as Epithelium, &c., which in all probability came from the Wards themselves.

In the Wards it is evident that the ventilation is generally bad and insufficient, the air actually supplied being unevenly distributed, and to a large extent wasted. This is seen by the large amount of Carbonic Acid and Organic Matter, and also by the character of the suspended matter. It is also to be noted, that in the majority of cases there was a more or less strong current setting in from the closets, so that it was in part *water-closet air* that was supplied in many cases; a powerful argument (if any were needed) to prove the necessity of separating the closets from the Wards as much as possible. The night of examination was on the whole rather favourable for the Wards, for the temperature was not too low, and there was not sufficient movement of air to prevent the windows being open to a considerable extent. Had the weather been colder and the windows shut, the air would undoubtedly have been much more foul.

In the "Accident" Ward, the case for the removal of the screen is very strong, for in its vicinity a large excess of Carbonic Acid and Organic Matter was found, whilst the microscopic characters of the suspended matter (showing not only a great deal of Epithelium but even pus globules) were markedly indicative of bad ventilation.

Among the recommendations of my first Report, I proposed that there should be a minimum of ventilation opening per head to the extent of 60 square inches for the ground floor, and a proportionately greater amount for the upper floors. Of this only *one-third* is to be admissible by means of windows, and even this on the understanding, that if it be necessary to shut the windows, there shall be such a velocity in the permanent ventilators as will make up for it. Thus, if there be 20 inches of permanent inlet, a velocity of 8 linear feet per second, or 480 per minute, will be necessary to supply 4000 cubic feet of air per hour. If this be found impracticable the sectional area must be increased. It must, of course, be understood that the temperature is not to be reduced too low; I think about 63 ° F., a good temperature, but anything below 60 ° F. ought to be avoided as much as possible. If the temperature gets too low, the ventilators will be closed wherever people can get at them. If we assume that the mean difference between the Wards and the outer air be 10 ° F., then (allowing $\frac{1}{2}$ for friction) we should have on the ground floor a

Mean velocity of 431 linear feet per minute.
On the First Floor 374 ,, ,,
On the Second ,, 301 ,, ,,

When the external air rose in temperature, the velocity would be proportionately diminished; but this could be made up for by opening the windows. On the other hand, in winter, the difference might amount to 20 ° F., or even 30 ° F., by which an amply sufficient current would be established. Thus:—

		Linear Feet per minute.
For a difference of 20 ° F.	Ground Floor	623
	First ,, ...	530
	Second ,, ...	428
For a difference of 30 ° F.	Ground Floor	764
	First ,, ...	650
	Second ,, ...	522

Even in summer it would seldom happen that the difference was less than 3° F. to 5° F. at night, and this would give:—

For 3° F.	Ground Floor.	242	linear feet per min.
	First Floor.	. 205	,, ,,
	Second Floor	. 166	,, ,,
For 5° F.	Ground Floor.	312	,, ,,
	First Floor.	. 265	,, ,,
	Second Floor	. 213	,, ,,

Now, as 480 feet per minute gives just 4000 cubic feet per hour through a 20-in. opening, we should require the following amounts, independent of windows:

		Sqre. Inches.
For a mean difference of 10° F.	Ground Floor.	$20 + \frac{480}{431} = 22{\cdot}7.$
	First Floor. .	$20 + \frac{480}{374} = 25{\cdot}7.$
	Second Floor .	$20 + \frac{480}{301} = 32{\cdot}0.$

In the winter the supply of air through such openings would be ample, even with the windows shut. Thus:

Difference of 20 ° F. . 5650 cubic feet per hour.
,, 30 ° F. . 7100 ,, ,,

In the summer the amounts would be:

Difference of 3 ° F. . 2180 ,, ,,
,, 5 ° F. . 2800 ,, ,,

Leaving a balance of from 1200 to 1800 cubic feet, to be supplied by the windows, which might be easily accomplished.

The condition of the Great Staircase illustrates the way in which the foul air of the Hospital gets mixed together, with the chance of its re-delivery into the Wards, and is an argument in favour of the isolation and separate ventilation of the individual Wards, the doors of which ought to be kept carefully shut.

The necessity for avoiding accumulation of dust, &c., is well shown by the microscopic condition of the air. I would further recommend that, as far as possible, the airing of linen, &c, should not take place in the Wards. The immediate destruction of all dressings, &c., and the instant disinfection of all stools are, of course, evident necessities.

I would call the attention of the Committee to the situation of the laundry, immediately under Foresters' Ward, a most objectionable place. It must be difficult to ventilate it except by the open windows, from which the steam must find its way into the Wards above, interfering with the diffusion of air, and arresting and adding to the Organic and suspended matter. It would be very desirable to remove it out of the building, and I would suggest that the separate building known as the Cottage, should be adapted for the purpose. I believe it is proposed to utilise that building as an Erysipelas Ward; but it seems to me very badly suited for it;—besides which, I think that if proper ventilation be supplied in the Hospital itself, there will be but little necessity for a separate Erysipelas Ward. This might be still further assured by a strict adherence to the antiseptic method of dressing of Professor Lister.

I beg to point out that the Sisters' Rooms, as well as the Nurses' Dormitories, are badly ventilated, and would require some attention.

I have discussed with the architect, Mr. Salter, the plans for the ventilation of the Wards, and those proposed are the following:—

1.—The introduction of ventilating tubes on both sides of the Ward, and at the end also, if possible.

2.—The introduction of large Sheringham valves in all the outer walls.

3.—The lowering of existing windows in several instances, and the breaking out of windows where required.

4.—The introduction of outlets at convenient points, such as shafts over the gas burners, which might be placed in the centre of the ceiling to aid the up-draught.

If it were possible it would be a good thing to have fresh air brought in *under* the beds also; but if this cannot be done, it is hoped that the greatly increased general supply of air will prove sufficient.

I have also suggested that arrangements should be made to clear the ventilating tubes of dust in such a way as not to bring any of it into the Ward.

In conclusion, I beg to say that if the proposed alterations can be carried out, there is fair reason to hope for a successful result. It would, however, be well to put it to a practical proof by another experimental inquiry when the Hospital is re-occupied and in full working order.

F. DE CHAUMONT, M.D., *Surgeon Major.*

Conjoint Professor of Hygiene, Army Medical School.

July 20th, 1875.

Table of Results of Experimental Inquiry at St. M[illegible] Hospital, Paddington, W., July 2nd & 4th, 1875.

DETAILS.	External Air, night of July 2nd.	"Victoria" Fem. Medical 1st Floor.	"Cambridge" Male Medical 1st Floor.	"Manvers" Fem. Surgical 2nd Floor.	Thistlethwayte Male Surgical 2nd Floor.	Accident Ward, Male. Ground Floor.					"Foresters" Male Accident Ground Floor	Great Staircase.	General mean of Wards examined.
Barometer: inches	29,700												
Meteorological Observations. Temperature Fahrenheit. Dry Bulb	58°5	65°0	67°0	68°0	69°5			69°0			69°5		68°0
Meteorological Observations. Temperature Fahrenheit. Wet ditto	58°0	62°0	64°5	64°0	64°8			63°0			65°5		64°0
Meteorological Observations. Temperature Fahrenheit. Dewpoint	57°5	59°5	62°5	60°8	62°2			58°3			62°4		60°8
Meteorological Observations. Vapour. Grains. In a cubic foot of air	5·2	5·6	6·2	5·8	5·9			5·3			6·2		5·8
Meteorological Observations. Vapour. Grains. Required to complete saturation	0·2	1·2	1·1	1·7	2·0			2·5			1·7		1·7
Meteorological Observations. Humidity per cent.	97	83	85	78	75			68			78		78
Meteorological Observations. Wind, direction and force	S.W. slight.												
Meteorological Observations. Ozone	nil	nil	nil	nil	nil			nil			nil		nil
Meteorological Observations. Weather	Damp, still												
Beds. Total number	.. ..	15	10	13	16			18			10		
Beds. Occupied	.. ..	all	all	all	12			all			all		
Per Bed. Floor space in square feet	.. ..	115	137	132	112			111			137		122
Per Bed. Cubic space. Total	.. ..	2077	2470	2383	2027			2164			2678		2256
Per Bed. Cubic space. Effective, height limited to 12 ft.	.. ..	1390	1650	1590	1360			1340			1620		1465
	General mean of 31 observations					S[illegible] or Windward side.		North, or Leeward side.		General mean			
						[illegible]ds, W[illegible] side	4 Beds, Screen.	4 Beds, Screen.	5 Beds, Window side	Ward.			
Carbonic Acid in 1000 volumes. Total	0·560	1·020	0·749	0·855	0·817	[illegible]26	0·802	0·946	0·801	0·819	0·855	1·007	0·847
Carbonic Acid in 1000 volumes. Respiratory Impurity.	.. ..	0·460	0·189	0·295	0·258	[illegible]66	0·242	0·386	0·241	0·259	0·295	1·447	0·287
Air supplied and utilised per head per hr. calculated from the respiratory impurity in cubic feet.	.. ..	1310	3170	2030	2330	[illegible]20	2480	1560	2500	2220	2030	1350	2080
Times air had been changed; standard being twice an hour. Per hour	.. ..	0·64	1·43	0·87	1·18	[illegible]2	1·18	0·74	1·18	1·02	0·80		0·92
Times air had been changed; standard being twice an hour. in 24 hours	.. ..	15½	34½	21	28½	[illegible]1	28½	18	28½	24½	19		22
Oxygen required for Oxydisable matter. milligrammes per cubic metre	1·4300	not determined.	1·4900	not determined.	1·5100			1·3600			not determined.		1·4500
Ammonia. Free do.	0·3574		0·6680		0·6469			0·3519					0·5556
Ammonia. Albuminoid do.	0·5280		0·4710		0·4770			0·6915					0·5465

from the Author

THIRD REPORT

ON

THE SANITARY CONDITION

OF

St. Mary's Hospital,

PADDINGTON, W.

EXPERIMENTS CARRIED ON
FROM 15TH TO 18TH AUGUST, 1876, AFTER THE
COMPLETION OF THE ALTERATIONS.

JOHN ELLIOTT & SON, STEAM PRINTERS,
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1877.

THIRD REPORT

ON

ST. MARY'S HOSPITAL,

PADDINGTON, W.

EXPERIMENTS CARRIED ON FROM 15TH TO 18TH AUGUST, 1876, AFTER THE COMPLETION OF THE ALTERATIONS.

THE various improvements determined upon after the presentation of the last Report having been carried out during the autumn and winter, it was arranged that a further examination of the Hospital should be made this summer, with a view to see how far the alterations had been satisfactory. The changes made have been mainly the following:—

1.—The Wards have been cleared of all irregularities of outline (as far as could be accomplished) by the removal of the Sculleries, Sinks, &c., which were most objectionable, both on Hygienic grounds, and as being unsightly.

2.—The Closets, Sculleries, &c., have been separated from the Wards and placed in annexes connected with the Wards by means of passages with cross ventilation.

3.—The openings in the walls of the Wards, either to the lobbies or to other rooms, have been closed, some (although unfortunately not all) have been bricked up, and others shut, where there were windows formerly capable of being opened.

4.—Additional ventilation has been provided for the Wards by the introduction of Tobin's Tubes, Sheringham Valves, and more window space.

from the Author

THIRD REPORT

ON

THE SANITARY CONDITION

OF

St. Mary's Hospital,

PADDINGTON, W.

EXPERIMENTS CARRIED ON
FROM 15TH TO 18TH AUGUST, 1876, AFTER THE
COMPLETION OF THE ALTERATIONS.

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1.—The Wards have been cleared of all irregularities of outline (as far as could be accomplished) by the removal of the Sculleries, Sinks, &c., which were most objectionable, both on Hygienic grounds, and as being unsightly.

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4.—Additional ventilation has been provided for the Wards by the introduction of Tobin's Tubes, Sheringham Valves, and more window space.

5.—Additional means of warming have been given by increasing the number of fireplaces.

6.—Lobbies and passages have been opened up, so that none now end as formerly, in *culs-de-sac.* Tube ventilators have also been introduced in most available places.

7.—Increased outlet has been provided in the cupola of the great staircase.

8.—The Out-Patients' Department has been remodelled and a new access provided, the whole being shut off by means of a glass partitition and door from the rest of the building.

9.—The ash-pit has been altered and placed in a better position, as far as circumstances allowed.

10.—The "Accident" Ward has been improved by the removal of the central screen, and the introduction of central ventilation tubes.

11.—The centre window of "Foresters'" Ward has been lowered and converted into a door, from which, across a light bridge, access is now obtained to the garden.

The general effect of the alterations has been greatly to improve the appearance of the Hospital, and especially the cheerfulness of the Wards; there is also a marked diminution of the Hospital odour more or less noticeable formerly.

The plan of examination adopted was similar to that followed on the former occasion, the same Wards being selected for purposes of comparison. It so happened that the time pitched upon occurred during one of the hottest and most oppressive weeks of this exceptionally hot summer; so that the circumstances were somewhat trying for the new system, the external temperature sometimes exceeding the internal, even at night. Last year there was, on the night of experiment, a mean difference of about 10 ° F. between the outside and the wards, the external temperature being low for the month of July. This time the mean difference was less than

half that amount; whilst one night the outer air was distinctly warmer. On account of the somewhat exceptional conditions of weather, the experiments were not confined to one night, but were repeated three times, so as to get as fair an idea as possible of the true condition.

EXTERNAL AIR.

Meteorological Conditions.—The weather was very dry and warm, and the barometer readings high. On the night of the 15th of August, (first night of experiments), the temperature ranged from 84 ° F. at 4 p.m., to 79 ° F. at 10 p.m., higher than that of the wards inside. Humidity 45 to 53 per cent. On the 16th the Temperature was lower, about 69 ° F.; Humidity, 60 per cent. On the 17th it was 68 ° F.; and the Humidity, 68; and on the 18th (when experiments were made in the Great Staircase) it was 69 ° F., with a Humidity of 93 per cent., the sky being overcast, and there being a tendency to rain. The wind was E. to S.E., moderate to fresh; except on the 18th, when it veered to S.W. The barometer stood most of the time at or about 29·900, or nearly the normal standard, (760 mm.)

Carbonic Acid.—The Carbonic Acid was determined 28 times, partly in the Hospital grounds, partly on the roof, and partly in the neighbouring streets. On the 15th, at 5 p.m., the mean was 0·298 per 1000 volumes, very low for London; at 10 p.m., it was 0·648, the increase being chiefly due to one very high determination, which I did not feel myself at liberty to reject. The mean of the night was 0·475. On the 16th the mean on the roof of the Hospital was 0·528, at 6 p.m.; and in the surrounding streets (at 1 a.m., 17th), 0·361; mean of the night, 0·444. On the 17th the mean in the Hospital grounds at 11 p.m., was 0·312. On the 18th, at 10 p.m., in the same locality, 0·368. The general mean of all the observations came to exactly 0·400, the usually accepted normal ratio. The mean of the times coincident with the Ward observations was 0·416, except in the case of Foresters', and the detailed observations in the Accident Ward, when it was 0·428, neither differing very widely from the general mean.

Oxygen required for Oxidizable Matter.—Air was carried through distilled water by means of aspirators during the whole time, the total amount so washed being 735 litres, or nearly three quarters of a cubic mètre, (nearly 26 cubic feet). The amount of Oxygen required for the *Oxidisable Matter (total)* was 0·5714 milligrammes per cubic mètre, a quantity less than half that found last year (1·43.) This was probably due to the greater dryness of the air. Differentiating the Oxidisable Matter, it was found that *Organic Matter* proper took 0·4444, and the remainder showed the presence of 0·3651 of *Nitrous Acid.* (N.B.—This was determined in the same way as in the case of water by boiling with Sulphuric Acid, and calculating from the difference).

Ammonia.—The *Free* Ammonia showed 0·0163, a much smaller amount than last year, (0·3574.) The *Albuminoid* Ammonia showed 0·5206, almost the same (a little decrease) as last year, (0·5280.) This is very high; but it might be expected that the state of the atmosphere would probably influence this less than the Free Ammonia, due, as it must be, in some measure to solid matter, to which the surroundings of the Hospital render it only too accessible.

Nitric Acid.—This was also determined by the Ammonia process; it amounted to 6·3923 milligrammes per cubic mètre, a very considerable amount. This, however, includes both the Nitrogen Acids, and the quantity of Nitrous Acid determined ought to be deducted, 6·3923 − 0·3651 = 6·0272 of Nitric Acid alone.

Suspended Matter.—For a detailed account and drawings, see latter part of Report.

WARDS.

In the experiments in the Wards, the plan adopted was the following:—

1.—On the 15th samples of air were collected for Carbonic Acid at two different times, viz., in the afternoon from 4 to 7, and at night between 10 and midnight. The Wards were in their usual condition, and the night being warm, most of the windows were open. The hygrometric conditions were also determined, and as far as time permitted, the rate of movement in the ventilators observed.

2.—On the 16th, all the openings in the Wards, with the exception of the Tobin's Tubes and the fireplaces, were shut up for a little time before taking the samples. Only one set of observations was made.

3.—On the 17th another set of observations was made, with everything open as on the first night.

4.—The air-washings for Organic and Suspended Matters were carried on continuously, and the results finally determined for each Ward in a single operation, as in the outer air.

The Tables at the end give the details of the observations in the order in which they were taken; but I shall in the Report take each Ward separately, and make such remarks as seem to suggest themselves. It may be convenient to take the Wards in the order of the former Report.

VICTORIA. FEMALE MEDICAL.

1st Floor.

August 15th. This Ward has now 16 beds, of which 15 were occupied on the 15th of August. There was no close smell on entering, either at 4 p.m. or 10 p.m. At 4 p.m. the Temperature was 81 ° F.; and the Humidity ·53 per cent. The average of four samples of air gave 0·519 of Carbonic Acid per 1000 vols., showing an excess over the outer air of 0·221 per 1000 as Respiratory Impurity. This indicates (by the usual formula) a supply of fresh air per head per hour of 2,720 cubic feet as really utilised, or the air was changed effectively at the rate of 29½ times in the 24 hours. At midnight the Temperature was 79 ° F.; and the Humidity 59. The average of four samples of air gave 0·717 per 1000 of Carbonic Acid, or Respiratory Impurity, amounting to 0·069. This indicated the extraordinary amount of 8,700 cubic feet of air per head per hour, or the air was changed at the rate of 95 times in the 24 hours. The mean of the night's observations gave:—Temperature, 80 ° F.; Humidity, 56; Carbonic Acid (total), 0·618; Respiratory Impurity, 0·143; Air supplied and utilised, 4,260 cubic feet per head per hour; or the air was changed effectively at the rate of 46½ times in the 24 hours. This is *good ventilation.*

The rates of movement in the Tobin tubes were examined, with the following results:—

On the East side (windward), all the tubes showed an incoming current, average rate + 292 linear feet per minute.

On the West side (leeward), all showed an incoming current, average rate + 95·3 linear feet per minute.

At the South end they showed an outgoing current at an average of − 231. There were, therefore, 28,600 cubic feet per hour coming in, and 7,200 going out by the tubes. This gives a supply of + 1,910 cubic feet per head per hour, or a good deal less than the quantity calculated from the Carbonic Acid. It is therefore clear that the difference must have been supplied by the windows and other openings. The Ward contains 11 tubes, 5 Sheringham valves (near the ceiling), and 12 windows, all of which were open.

August 16th. On the 16th everything was shut up, except the tubes. As it happened, the order was given about 6 p.m.; but from the length of time the experiments took, the Ward was not reached till 11 p.m.; it then

felt very hot, though not distinctly close. Its condition was:—Temperature, 78 ° F.; Humidity, 59; Carbonic Acid (mean of four), 1·309 per 1000; Respiratory Impurity, 0·865; showing only 695 cubic feet of air per head per hour supplied and utilised. This night the 16 beds were all occupied. The air, from the above calculation, was being changed at the rate of only eight times in the 24 hours.

The movement of air in the ventilators was as follows:—

East side, all the tubes showing an incoming current, average rate + 344 per minute.

West side.	2 tubes showed an	incoming	current,	average	+217
	2 „ „	outgoing	„	„	−728
End	2 „ „	„	„	„	−231

This gave + 33,650 and − 18,560 cubic feet per hour.

The difference between the incoming and outgoing air was probably provided for by the chimneys, (in one grate there was a fire.) This amount of air gave + 2,103 per head, or 3½ times that calculated from the Carbonic Acid. It was therefore evident, either that the air was badly distributed—a large part of it going to the upper part of the room or to the fire—or that the current was not regular; both causes were probably at work.

August 17th. On the 17th the Ward was in its ordinary condition, windows and Sheringham valves being open. There were only 14 beds occupied. A fire burned in one grate. There was no close smell, and the following were the conditions:—Temperature, 74 ° F.; Humidity, 74; Carbonic Acid (mean of four) 0·577; Respiratory Impurity, 0·265; Air supplied per head per hour, 2,270; or the air was changed effectively at the rate of 23 times in the 24 hours.

Of the 11 tubes, 6 showed an incoming current, and 5 an outgoing; giving + 45,650 and − 15,920 cubic feet per hour, equal to about 3,250 per head. It was very difficult to test the Sheringham valves, on account of their great height from the floor; but on trying them all showed a powerful incoming current. A great deal of air was evidently being wasted from bad distribution.

Mean of Three Nights. The mean results of the three nights gave:—

Temperature 77° 3. Carbonic Acid (total) . . 0·835
Humidity, 63. „ Respiratory Impurity 0·435
Air supplied per head per hour, 1,380; Air changed 15 times in the 24 hours.

This result comes out almost identical with that of last year; but it must be remembered that the latter was a single night's observation, taken under ordinary circumstances with the windows open; whereas the present includes a night when all the windows were closed, at a very high temperature. Taking the two nights of the present inquiry, when everything was open, we find that the first night showed an increase of 225 per cent. on the air supplied, and the last (although less favourable) fully 70 per cent., or a mean of about 150 per cent. of increase. It is also to be noted that no *close* smell was detected, partly because the general ventilation was better, and partly on account of the lessened Humidity.* On the whole, we may consider it demonstrated that a very great improvement has taken place in the ventilation of the Ward.

Organic Matter.—Last year the Organic Matter was not determined chemically in this Ward; this time it has been done with the following results:—

Ammonia, Free . .	0·0497	Milligms. per cub. met.
„ Albuminoid	0·4622	„ „
Oxygen required for Oxidisable Matter:—		
Total . . .	0·5621	„ „
For Organic Matter only	0·3747	„ „
Total Nitrogen Acids .	5·0052	„ „
Of which Nitric Acid	4·4665	„ „
Nitrous „	0·5387	„ „

* On the influence of Humidity in modifying *Closeness*, as judged of by smell, see my paper in the Proceedings of the Royal Society, No. 171, 1876.

The *Albuminoid Ammonia* and the *Organic Oxygen* are both less than those of the outer air, although the Free Ammonia is greater; the total Nitrogen Acids are less; but the Nitrous Acid is slightly higher. The total amount of air washed was 747 litres (about 26½ cubic feet.) For *Suspended Matter* see latter part of Report.

CAMBRIDGE. MALE MEDICAL.

1st Floor.

This Ward has 12 beds, of which 11 were occupied.

August 15th. There was no close smell. On the 15th, at 5.30 p.m., the windows, doors, and ventilators were all open. Temperature, 80 °; Humidity, 56; Carbonic Acid (mean of three), 0·702 per 1000; Respiratory Impurity, 0·404; Air calculated per head, 1,495; or the air was changed at the rate of 17 times in 24 hours. At 11 p.m. the Temperature and Humidity were the same; but the Carbonic Acid (mean of four samples) was 0·794, giving a Respiratory Impurity of 0·146. This showed a supply of air equal to 4,210 cubic feet per head per hour; or the air was changed at the rate of 45 times in 24 hours. The mean of the night showed a Respiratory Impurity of 0·273, giving 2,200 cubic feet per head per hour; or the air was being changed at the rate of 24 times in 24 hours.

Of the ventilators (eight tubes) five showed an incoming and three an outgoing current, giving a total of + 21,970 and − 7,380 cubic feet. This indicates a supply of + 1,997 per head, or only 200 less than the amount calculated. Of course, fresh air was also coming in by the windows, and outgoing currents passing up the chimney.

August 16th. On the 16th everything, except the tubes and fireplaces, was shut for about three quarters of an hour, just before the experiments. Half an hour after midnight the Ward felt hot, but not close. Temperature, 75 ° 9; Humidity, 64; Carbonic Acid (mean of four samples), 0·572; Respiratory Impurity, 0·128; air calculated per head, 4,700 cubic feet; or the air was changed at the rate of 50 times in 24 hours, a very good result.

Six of the ventilating tubes gave an incoming and two an outgoing current. Total, + 19,830 and − 3,550 cubic feet. This gives per head only + 1,803 against 4,700 calculated. Probably a good deal of air came in through Galton's ventilator, which was left open; and of course a large amount would find an exit up the chimney.

August 17th. On the 17th the Ward was in its usual condition, windows, etc., being open; there was no close smell. Temperature, 71 ° 2 F.; Humidity, 82; Carbonic Acid (mean of four samples), 0·671; Respiratory Impurity, 0·359; Air supplied per head, 1,680 cubic feet per head per hour; or the air was changed 17 times in 24 hours. This comparatively poor result was probably due to the small difference of temperature between the Ward and the outer air, only 3 ° 2; perhaps, also, to the increased Humidity, and the shifting of the wind. The ventilators were not tested this night.

Mean of 3 Nights. The mean of the three nights was as follows: Temperature, 75 ° 7; Humidity, 66; Carbonic Acid, 0·662; Respiratory Impurity, 0·246; Air supplied per head, 2,440; Air changed 26 times in 24 hours. This result is apparently less good than last time; but it must be remembered that the test was severe on the present occasion, the mean difference of Temperature being only 3 ° 9, against 8 ° 5 last time.

Organic Matter. The Organic Matter of 752 litres (about 26¾ cubic feet) of air was examined:—

Ammonia, Free . .	Nil.		
„ Albuminoid	0·2824	millgms. per cub.metre.	
Oxygen for Oxidisable Matter:—			
Total.	0·5142	millgms. per cub.metre.	
For Organic Matter only	0·2571	„	„
Total Nitrogen Acids .	28·4846	„	„
Of which was Nitrous.	0·7392	„	„
„ „ Nitric .	27·7454	„	„

Comparing this with last year's determination, we find:

Free Ammonia, diminished from 0·6680 to nil.
Albuminoid ditto, „ 40 per cent.
Total Oxygen „ 65 per cent.

All the quantities are also less than those of the outer air, except the Nitrogen Acids, which are in very large quantity.

For *Suspended Matter* see latter part of Report.

MANVERS. FEMALE SURGICAL.

2ND FLOOR.

August 15th. This Ward has 14 beds, which were all occupied during the inquiry. On the 15th, at 7 p.m., the windows and ventilators were all open; no smell. Temperature, 79 ° 9; Humidity, 79; Carbonic Acid (mean of three), 0·660; Repiratory Impurity, 0·362; Air calculated as supplied per head, 1,660 cubic feet; Air changed 16⅔ times in 24 hours. At 11.30 p.m. the Ward was hot; but not close. The upper parts of the windows were open. Temperature, 80 ° F.; Humidity, 80; Carbonic Acid (mean of three samples), 0·520; Respiratory Impurity (?) not calculable, as the outer air ratio was higher. This indicated an unlimited supply of air! The mean of the night's experiments gave: Temperature, 79 ° 95; Humidity, 80; Carbonic Acid, 0·590; Respiratory Impurity, 0·115; showing air supplied to the amount of 5,220 cubic feet per head per hour; or the air changed 53 times in the 24 hours, a very large amount.

There are 12 tubes, 12 windows, and 5 Sheringham valves, all open. Of the tubes, 4 gave an incoming and 8 an outgoing current. Total amount + 19,370 and − 12,295. This gives + 1,384 per head, or nearly the amount calculated at the first time.

August 16th. On the 16th everything (except the tubes and fireplaces) had been shut up for half an hour previous to the experiments. At 11 p.m. it was a little close and felt hot. Temperature, 73 °; Humidity, 70; Carbonic Acid (mean of 5 samples), 0·703; Respiratory Impurity, 0·259; Air calculated as supplied per head, 2,320; or air changed at the rate cf 23 times in 24 hours.

The ventilators showed 6 tubes giving an incoming and 6 an outgoing current. Total air + 30,420 and − 30,920; showing about 2,200 feet of air supplied per head per hour—very near the calculated amount. We may therefore take it that the air was well distributed.

August 17th.

On the 17th the Ward was in its usual condition, with open windows, &c.; there was no smell. Temperature, 72 °; Humidity, 80; Carbonic Acid (mean of four samples), 0·571; Respiratory Impurity, 0·259; Air calculated as supplied per head per hour, 2,320 cubic feet; or the air was changed at the rate of 23 times in the 24 hours. Here, oddly enough, the result comes out identical with that of the previous night.

The ventilators were examined on the following day (18th), and showed 8 tubes giving an incoming and 4 an outgoing current. Total air, + 13,576 and − 9,560, or + 970 per head. All the Sheringham valves showed strong outgoing currents. Total, − 44,940; fireplaces, − 38,050; total, − 86,910. Besides this there was air coming in by the windows, and the Galton ventilator at the fireplace. Of the air utilized, about two-fifths were supplied by the tubes, and the rest by the windows and other openings.

Mean of the Three Nights.

The mean of the three nights gave: Temperature, 75 ° F.; Humidity, 62; Carbonic Acid, 0·630; Respiratory Impurity, 0·214; Air calculated per head, 2,810; or air changed at the rate of 34½ times in the 24 hours. Comparing this with last year, there is an improvement of 40 per cent., even under the present somewhat disadvantageous circumstances.

Organic Matter.

The Organic Matter (which was not examined last year) showed the following:—

Ammonia, Free. . .	0·0310	millgms. per cub. metre.	
„ Albuminoid	0·3576	„	„

Oxygen required for Oxidisable Matter:—

Total . . .	0·4342	„	„
For Organic matter only	0·3101	„	„
Total Nitrogen Acids.	13·8070	„	„
Of which Nitrous Acid	0·3567	„	„
Nitric Acid .	13·4503	„	„

The Free Ammonia is higher than that of the outer air; but the other constituents are lower, except the Nitric Acid.

For Suspended Matter, see latter part of Report.

THISTLETHWAYTE. MALE SURGICAL.

2nd Floor.

August 15th.

This Ward has now 18 beds, of which 17 were occupied throughout the inquiry. On the 15th, at 6 p.m., the windows and ventilators were all open, and there was no close smell. Temperature, 80 °; Humidity, 52; Carbonic Acid (mean of three samples), 0·476; Respiratory Impurity, 0·178; Air calculated as supplied per head per hour, 3,370; or the air was changed 37½ times in 24 hours. At 10.30 p.m., although the Ward generally was not close, there was a peculiar smell at the end of rather an unpleasant character. It did not come (as far as could be ascertained) from the Ward itself, or the closet; and most probably came from the dust-yard in the neighbourhood. Temperature, 78 °; Humidity, 59; Carbonic Acid (mean of three samples), 0·722; Resiratory Impurity, 0 074; Air calculated as supplied per head per hour, 8,140, a very large amount; the air was being changed at the rate of 91½ times in 24 hours. The mean of the night's experiments gave: Temperature, 79 °; Humidity, 57; Carbonic Acid, 0·599; Respiratory Impurity, 0·124; Air calculated per head, 4,860; or the air was changed at the rate of 54 times in 24 hours. *This is a most satisfactory condition of ventilation.*

There were 12 windows, 5 Sheringham valves, and

9 tubes open, besides the fireplaces. Of the tubes, 7 gave an incoming and 2 an outgoing current, total + 14,240 and — 6,320, giving per head only + 720, so that by far the larger part of the air was supplied through the windows, &c.

August 16th. On the 16th, everything, except the tubes and fireplaces, was closed for half an hour. Ward felt hot and rather close. Temperature, 72°; Humidity, 79; Carbonic Acid (mean of 5 samples), 0·727; Respiratory Impurity, 0·282; Air calculated per head, 2,120; or air changed at the rate of 22 times in 24 hours.

Of the ventilating tubes, 5 gave an incoming and 3 an outgoing current. Total air + 35,720 and — 14,700, giving per head, 2,100; or the measured delivery was identical with the calculated, showing that the air, though not quite sufficient in quantity, was well distributed. A large part of the foul air passed, of course, up the chimneys.

August 17th. On the 17th all the windows and ventilators were open as usual, and there was no smell. Temperature, 71°9; Humidity, 86; Carbonic Acid (mean of 4 samples), 0·564; Respiratory Impurity, 0·252; Air calculated as supplied per head, 2,380; or the air was changed at the rate of 25 times in 24 hours.

The ventilators were not examined.

Mean of the Three Nights. The mean of the 3 nights gave the following: Temperature, 74°3; Humidity, 73; Carbonic Acid, 0·630; Respiratory Impurity, 0·214; Air supplied per head per hour, 2,810; or the air was changed at the rate of 34½ times in the 24 hours. This is not yet up to the desired standard; but it is an improvement of 25 per cent. upon last year.

Organic Matter. For Organic Matter, 738 litres (about 26 cubic feet) of air were washed with distilled water, with the following results:—

Ammonia, Free	0·0127
„ Albuminoid	0·5259

Oxygen required for Oxidisable Matter:—

Total	0·4451
For Organic Matter only	0·2225
Total Nitrogen Acids	25·4778
Of which was Nitrous	0·6398
„ Nitric	24·8380

These show, compared with last year, a diminution of 98 per cent. in the Free Ammonia, and of 70 per cent. in the total Oxygen. There is, however, an increase of 11 per cent. in the Albuminoid Ammonia. Taking into consideration that this is the only case of increase, and also that in this Ward the only instance of disagreeable smell occurred, it is clear that some special cause must be at work. The only apparent cause seems to be the dust-yard above referred to, to which the Ward is particularly exposed. The Nitrogen Acids were very much above the outer air ratios; but the other constituents were less, except the Albuminoid Ammonia.

For *Suspended Matter* see latter part of Report.

ACCIDENT WARD. MALE SURGICAL.

Ground Floor.

The peculiarities of this Ward, and of its fellow, "Foresters'," were fully noticed in the former Report. The improvements effected have been these: The wooden screen at right angles to the door has been removed, and a free passage from the door to Foresters' Ward left open. On each side a light iron railing has been placed, to separate the beds in the centre of the room from the passers by. The beds remain as before—three on each side of the centre passage. At the head of each bed, a ventilating tube has been introduced; other tubes have also been placed round the walls. The Ward has now a much pleasanter appearance.

August 15th. On the 15th August, at 4.30 p.m., there was no close smell, although it was very hot. Temperature, 82 ° F; Humidity, 52; Carbonic Acid (mean of 5 samples), 0·569; Respiratory Impurity, 0·271; Air calculated as supplied per head per hour, 2,220; or the air was changed at the rate of 20½ times in the 24 hours. These observations were taken in the north-west or leeward half of the Ward. All the windows and ventilators were open, and there was a brisk fire burning in one of the fireplaces. At 10 p.m. it was hot. Temperature, 78 °; Humidity, 67; Carbonic Acid (mean of 5 samples), 0·612, which was under the outer air ratio. These observations were made in the south-east, or windward side of the Ward. Of the 18 beds the Ward contains, 15 were occupied. The mean of the night gave: Temperature, 80 ° F.; Humidity, 58; Carbonic Acid, 0·590; Respiratory Impurity, 0·115; Air supplied per head, 5,230; or the air was changed at the rate of 48 times in 24 hours. *This was up to the standard of good ventilation.*

At 9.20 a.m., 15th. There are 14 tubes, 6 of which are by the centre beds, and the rest at the walls, 6 Sheringham valves, and 8 windows, all of which were open. Of the tubes, 4 gave an incoming and 10 an outgoing current. Total + 6,875 and − 13,140, respectively + 430 and − 821 per head. Evidently by far the largest part of the air supplied came through the other openings.

August 16th. On the 16th, everything, except the tubes, the fireplaces, and some of the old ventilators—which were, I think, overlooked—was shut up. There were 16 beds occupied, and a large fire and 6 gas-jets (lowered) burning. It was very hot, but not close. Temperature, 78 ° F.; Humidity, 67. Carbonic Acid; it was thought advisable, on account of the peculiar construction of the Ward, to make separate observations in different parts. Accordingly 8 samples of air were taken with the following results:—

Place.	Carbonic Acid.	Respiratory Impurity.	Air Supplied	No. of times changed in 24 hrs
Window side, N.W. (leeward)	0·646	0·202	2,960	29½
Centre, N.W. (leeward) . .	1·289	0·845	720	7
Window side, S.E. (windward)	0·709	0·265	2,270	22½
Centre, S.E. (windward) . .	0·721	0·277	2,160	21
Mean, window sides of Ward	0·677	0·233	2,580	25½
,, centre of Ward . . .	1·013	0·569	1,060	10
,, windward half of ditto	0·716	0·272	2,210	21½
,, leeward half of ditto .	0·970	0·526	1,145	11
,, whole Ward	0·842	0·398	1,515	15

Of the tubes, 4 on the north side showed an incoming current, the 6 in the centre showed the same, and the 4 on the south side an outgoing current. Total + 18,360 and − 3,310, giving per head + 1,148 and − 220. The difference between the measured and calculated amounts, doubtless came in through the old ventilators, and through chinks, &c. The chimneys, of course, supplied the necessary outlet.

August 17th. On the 17th, at 10 p.m., the windows and ventilators were open as usual; it was hot, but not close. Temperature, 78 °; Humidity, 71; separate determinations of the Carbonic Acid were made as before:—

Place.	Carbonic Acid.	Respiratory Impurity.	Air per head supplied.	No. of times changed in 24 hrs
Window side, S.E. (windward)	0·792	0·480	1,260	12
Centre, S.E. (windward) .	0·881	0·569	1,060	10
Window side, N.W. (leeward)	0·778	0·666	905	9
Centre, N.W. (leeward) . .	0·965	0·653	920	9
Mean, window sides . . .	0·882	0·570	1,060	10
,, centre	0·923	0·611	980	9½
,, windward half . .	0·836	0·524	1,145	11
,, leeward half . . .	0·971	0·659	915	9¼
,, whole Ward . . .	0·903	0·591	1,015	10

The causes of this poor result were probably several; among them, are the increase of humidity in the air, and the veering of the wind to the south of east. These, however, seem of themselves hardly adequate to account for it altogether.

MEAN OF THE OBSERVATIONS IN THE ACCIDENT WARD.

Means.

Temperature 78°7; Humidity 67. Carbonic Acid; the means of the 16th and 17th are given below, as the separate determinations were made on these nights only. The general means of the three nights are also added:

Place.	Carbonic Acid.	Respiratory Impurity.	Air per head supplied.	No. of times changed in 24 hrs
Window side, S.E. (windward)	0·750	0·322	1,865	18½
Centre, S.E. (windward) . .	0·801	0·373	1,610	16
Window side, N.W. (leeward)	0·812	0·384	1,565	15½
Centre, N.W. (leeward) . .	1·127	0·699	860	8½
Mean, window sides . . .	0·779	0·351	1,710	17
„ centre	0·968	0·540	1,135	11
„ windward half . .	0·776	0·348	1,725	17
„ leeward half . . .	0·970	0·542	1,110	11
„ whole Ward, from above Observations.	0·872	0·444	1,355	13¼

MEANS FROM THE THREE NIGHTS' OBSERVATIONS.

Mean, windward half . . .	0·721	0·305	1,970	19½
„ leeward half . . .	0·837	0·421	1,425	14
„ whole Ward . . .	0·778	0·362	1,660	17

The result is rather below that of last year; but the circumstances were much more trying, whilst on one night at least (the 15th) a much better result was obtained than formerly. When we look also to the Organic Matter, we find a marked improvement; 739 litres of air (about 26 cubic feet) were washed, with these results:—

Organic Matter.

Ammonia, Free . .	0·0100	Milgms. per cubic metre.
„ Albuminoid	0·3684	„ „
Oxygen for Oxidisable Matter:—		
Total . .	0·6315	„ „
For Organic Matter only	0·4420	„ „
Total Nitrogen Acids.	17·8072	„ „
Of which was Nitrous	0·5447	„ „
„ „ Nitric.	17·2625	„ „

We here find the Free Ammonia diminished 97 per cent., and the Albuminoid, 47 per cent.; both being materially lower than the outer air ratio. The total Oxygen is also less than last year by 54 per cent.; although both it and the Nitrogen Acids show an increase over the outer air ratio.

FORESTERS' WARD. MALE ACCIDENT.

GROUND FLOOR.

This Ward opens off the Accident Ward by a permanently open doorway. The changes have been the introduction of ventilating tubes, and the opening of a door to the garden in the centre, opposite the entrance door. This affords an access to the garden, and an easy means of flushing the place with air. There are 12 beds, all of which were occupied during the inquiry. No observations were made on the 15th instant.

16th August.

On the 16th all was closed for one hour, except the tubes, the fire places, and the access by the "Accident" Ward. There was no fire; and no close smell was detected. Temperature, 77° F.; Humidity, 67. In the Ward there was at one end a very bad case, from which a good deal of foul smell was said to come at times; accordingly samples of air were taken in that neighbourhood, and also in the opposite end of the Ward.

Place.	Carbonic Acid.	Respiratory Impurity.	Air calculated per head.	No. of times changed in 24 hrs
Near the bad case .	1·354	0·910	660	7
Opposite end . .	0·751	0·307	1,960	21
Mean of Ward . .	1·112	0·668	905	10

There were 10 tubes, 6 windows, and 4 Sheringham Valves; also door to garden: all open at 9.45 a.m., on the 16th.

5 tubes gave an incoming current, total + 4,380
5 „ outgoing „ − 3,760

At 10 p.m. same day (when the Carbonic Acid observations were made) all 10 tubes gave an incoming current total = + 12,950. This gives + 1,080 per head, or a little above the calculated amount (905). The foul air found its exit up the chimney.

17th August. On the 17th, at 10 p.m., all was open as usual; it was warm, but no bad smell. Temperature, 77°; Humidity, 75. Separating the observations as before, we have:—

Place.	Carbonic Acid.	Respiratory Impurity.	Air calculated per head.	No. of times air changed in 24 hrs.
Near bad case . .	1·049	0·737	820	9
Opposite end . .	0·926	0·614	975	10½
Mean of Ward .	0·979	0·667	900	9½

The mean of the two nights was as follows; Temperature, 77°; Humidity, 71.

Near bad case . .	1.201	0·773	780	8½
Opposite end . .	0·838	0·410	1,470	16
Mean of Ward * . Total No. of samples	1·045	0·617	975	10
Mean of the 2 ends	1·020	0·592	1,015	11

The *Organic Matter* was not determined.

The above is not a favourable result; but it must be remarked that experiments were made on two nights only; one when all the windows were closed, and the other when less favourable results were obtained in all the Wards. Had experiments been made on the 15th as well, it is probable that the mean result would not have been worse than that found in the Accident Ward. Under any circumstances, however, it shows the disadvantages of square Wards, arranged as these are. Thus, taking the two nights during which "Foresters'" was under examination, we have the following results:

Kind of Ward.	Carbonic Acid.	Respiratory Impurity.	Air calculated per head.	No. of times air changed in 24 hrs.
Square Ward, viz: Accident & Foresters'	0·959	0·511	1,140	11½
All the other Wards.	0.737	0·309	1,950	20
Square Ward, including Cambridge .	0·846	0·408	1,480	16
Long Wards . . .	0·742	0·314	1,920	21½

* N.B.—There were three samples near case, and two at opposite end, on each occasion.

The *Long Wards* also include the case of "Victoria" on the 16th, when it was shut up for 5 hours. Excluding that we should have for the *Long Wards*:—

Long Wards . . . 0·624 0·196 3070 34

A very fair result, though falling short of what we desire for Hospitals.

GENERAL MEAN OF ALL THE WARDS EXAMINED.

General Mean. Mean for August 15th: Temperature, 80°6; Humidity, 58; Carbonic Acid, 0·629; Respiratory Impurity, 0·154; Air supplied per head, 3810; Air changed 40 times in 24 hours.

Mean for August 16th: Temperature, 76°; Humidity, 67; Carbonic Acid, 0·877; Respiratory Impurity, 0·433; Air supplied per head, 1390; Air changed 14½ times in 24 hours.

Mean for August 17th: Temperature, 74°; Humidity, 78; Carbonic Acid, 0·711; Respiratory Impurity, 0·399; Air calculated per head, 1510; Air changed 17 times in 24 hours.

The general mean of the three nights for the whole of the Wards examined, was as follows:—

Temperature, 76°3. Carbonic Acid, 0·762.
Humidity, 67. External air ratio, 0·416.
Respiratory Impurity, 0·346.

Air supplied per head, calculated from Carbonic Acid, 1740.

Air changed in 24 hours, 19 times.

The Temperature was only 4°5 different from that of the outer air, whereas last year the mean difference was 9°5, a very material factor in the question. The Humidity this year was even below the adopted standard, 73. The mean total Carbonic Acid was less than last year; but the external air ratio being also lower, this makes the Respiratory Impurity appear higher, the difference being as 22 to 19. Reviewing, however, the circumstances, and the severe tests applied on the present occasion, it cannot be considered as showing an unsatisfactory result, although it falls short of what we desire. Looking, however, to the Organic Matter, the result isa very great improvement. We find the mean as follows :—

Organic Matter.

Ammonia, Free . .	0·0207	milligms.	per cub. mètre
„ Albuminoid	0·3993	„	„
Oxygen for Oxidisable Matter :—			
Total . . .	0·5174	„	„
For organic matter only	0.3213	„	„
Total Nitrogen Acids.	18·1163	„	„
Of which was Nitrous .	0·5638	„	„
„ Nitric .	17·5525	„	„

This shows a diminution of 96 per cent. in the Free, of 27 per cent in the Albuminoid Ammonia, and of 64 per cent. in the total Oxygen. In all, the amounts were less than the open air, except the Nitrogen Acids.

CENTRAL HALL AND STAIRCASE.

The change of circumstances in the Hospital may be well seen in the condition of the Centre Hall and Staircase, which were examined at 10 p.m. on the 18th.

Place.	Temperature.	Humidity.	Carbonic Acid.	Respiratory Impurity.	Air calculated per hd.
Ground Floor.	69 ° 8	76	0·238	? under outer air ratio.	
First Floor .	71 ° 4	86	0·456	0·088	6840
Second Floor .	71 ° 6	85	0·500	0·132	4550
Mean . . .	70 ° 9	82	0·394	0·026	23100

The Temperature outside was 69 °, and the Humidity 93, so that it was hardly possible to get the inside much lower. The outer air Carbonic Acid was 0·368; so that the Ground Floor determination gave a smaller amount. It is clear from the above the Staircase is well ventilated on its account, and is no longer a well, in which all the foul air of the building is mixed and redelivered.

OUT-PATIENTS' PASSAGE AND WAITING-ROOM.

This has been greatly improved, as already mentioned. On going down to it, when a considerable number of patients were present, no unpleasant smell was observable. The question has been raised as to whitewashing the wall of the passage from the street, on account of the patients rubbing against it; but it is doubtful if this would be advisable. I think washing the wall with soft soap and Carbolic Acid, periodically, would probably be better. Some means of cleaning certainly seem desirable. It might be suggested that glazed tiles should be put along the wall; these would not be unsightly, would be durable, and would admit of thorough cleansing with very simple means.

OPERATING THEATRE.

A gas stove with asbestos has been introduced, and some experiments were made to test its action. The doors were shut, and the stove lighted for about 20 minutes; the results were the following :—

		Per 1000.
Temperature, 95 °.	Carbonic Acid . . (Mean of 6 samples).	2·018
Humidity, 37.	Outer Air ratio . .	0·312
	(1 sample showed a ratio of 2·516)	

A considerable amount of Sulphurous Acid was also detected qualitatively. The air was most oppressive, as might be expected from the imperfect ventilation. There ought to be a cowl and flue to carry off the Carbonic Acid, heated air and unconsumed gas.

MICROSCOPIC OBSERVATIONS.

Drawings of the Suspended Matter collected are appended with a descriptive list. I am sorry that I have not been able on this occasion to avail myself of the artistic services of my friend, Dr. Macdonald, who is absent on leave; but I daresay the present drawings will convey a sufficient idea of the bodies seen. The first two show the substances found in the outer air, as seen with a $\frac{1}{4}$-inch and a $\frac{1}{12}$-inch objective. With regard to the objects in the Wards, I may observe that a good deal of *dust* was found—allowed to accumulate on tops of cupboards, ventilators, ledges, &c., and I thought it would be instructive to examine this in connection with the floating particles collected by means of the aspirators. In each Ward, therefore, are drawings given marked, "*Dust*," which may be compared with those of the floating particles. The focal length of the objective is noted in each case; $\frac{1}{4}$-inch being equal to about 225 diameters, linear; $\frac{1}{8}$, about 500; $\frac{1}{9}$, about 625; and $\frac{1}{16}$ immersion, about 750. In a few cases the objects are tinted,* to give an idea of the colours as seen in the field of the microscope, as in the case of dyed fibres in "Thistlethwayte" Ward. In this Ward, among other things, was detected a specimen of *Sarcoptes Scabiei*, or *Itch Insect*, in a larval form. In all the Wards Epithelium was found from the skin, and in some cases from the mouth too, but no pus was found. A number of Flagellate Infusoria were observed, and a large number of Bacteriform bodies, as well as actively growing Fungi. In "Foresters" the dust only was examined, the floating particles not having been collected.

With the outer air so charged with particles, it is difficult to keep the interior pure; but every care ought to be taken inside to favour the lodgment of suspended matter as little as possible. It is clear that if such substances as Epithelium can be collected in the dust of the Wards, the germs of all sorts of noxious matters may be expected to be present; whilst the undoubted presence of an Itch Insect must make it very easy to understand how disease can be propagated. I may remark that this is not the first instance of an Itch Insect being detected in the air, as I reported one some years ago in the examination of another building.

* In the original drawings.

CONCLUDING REMARKS.

In summing up the results of this inquiry we may consider several points:—

1. How far the condition of the Hospital has been improved by the alterations?
2. How far may the action of Tobin's Tubes be relied upon?
3. Are there any further points to be suggested for improvement?
4. What can be done to improve the surroundings of the buildings?

I. As regards the first question, I think there can be little doubt that the improvement has been considerable, both in the general appearance of the Wards, and in their ventilation. The weather was most unusual during the inquiry, and the test was a severe one; but the amount of air available was on the whole considerable, although falling short of what was desired. On the other hand; there was almost no close smell about the Wards, and no smell from the sinks and water closets. The Organic Matter was also much less than on the former occasion, even allowing for the different Hygrometric conditions.

II. With regard to Tobin's Tubes, the extent to which they might be depended upon alone may be gathered from the results of the 16th August, when they alone were left open, with the chimneys to act as outlets. In "Cambridge" the results were good; in "Thistlethwayte" and "Manvers," fair; in "Accident," poor; in "Foresters," and in "Victoria," very bad. The last had been shut up for five hours, whilst the others were only a short time closed. It is plain, therefore, that in hot weather at least, it is not possible to depend on them alone, in the number supplied. Perhaps if a larger number were introduced, the results would be better; but there would be some difficulty, practically, in dealing with the beams, &c. of the floors. It is claimed for the tubes, that they supply a steady inflowing current as required, without necessity for special outlets, except the ordinary chimneys. The examination by means of the Anemometer (Casella's small air meter), showed that the current was by no means constant, and that it was nearly as often outgoing as incoming. It is clear that the chimneys alone are insufficient as outlets. As to the quantity of air that can be obtained, we may examine this by Montgolfier's formula, according to temperature and height, and we find the following results :—

Table of Air available through Tubes, August 16th.

Ward.	Theoretical Amount.	Measured quantity.	Calculated from Resp. Impurity.	Amount allowing $\frac{4}{5}$ for Friction.
Victoria . .	74,000	33,650	11,120	16,300
Cambridge .	55,500	19,830	55,700	12,300
Manvers . .	57,000	30,420	32,500	12,600
Thistlethwayte	38,200	35,720	36,200	8,450
Accident . .	130,000	18,360	24,240	28,600
Foresters' . .	98,000	13,000	10,800	21,600

The last column is got by considering only about one fifth of the theoretical amount as likely to be obtained. This may seem very small; but if we consider the circumstances of the tubes it is not improbable. Thus the entry of the air through the outer grating will cause a probable loss of $\frac{1}{4}$; friction in the tube itself, $\frac{1}{4}$; the right angle in the tube, $\frac{1}{2}$; friction through the grating at the point of delivery into the Ward, $\frac{1}{4}$; so that the total remaining will be $\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2} \times \frac{3}{4} = \frac{27}{128} = 0{\cdot}211$, or about $\frac{1}{5}$ of the theoretical amount would be available for delivery. In the above table we find that the theoretical amount was actually supplied (and utilised) in "Cambridge" and "Thistlethwayte"; that the amount supplied approximated to the amount corrected for friction, in "Accident" and "Victoria"; and that the amount supplied and the measured amount approximated, to a certain degree, in "Foresters'," and closely, in "Manvers." Of course it is to be understood that the measured amounts are only approximative, and take no account of changes in the interval.

From the observations in the "Accident" Ward, it is very obvious that the direction of the wind has a marked influence on the amount of air supplied. It is here that Wards with windows only on one side suffer when they happen to be to leeward.

Another point that seems important, is the bearing of the Humidity of the outer air. The best results were obtained when the outer air was driest, as seen below :—

Date.	Temperature.	Humidity. Outer Air.	Wards.	Respiratory Impurity in Wards, (Omitting Foresters')	Air supplied per head per hour.
15th	81°5	49	61	0·154	3,910
16th	68°6	60	66	0·387	1,550
17th	68°	68	79	0·345	1,740

In the case of the "Accident" Ward we find the result to be :—

15th	81°5	49	58	0·115	5,230
16th	68°6	60	67	0·398	1,515
17th	68°	68	71	0·591	1,015

Here the coincidence is well marked.

Complaints have been made that the air from the tubes blows down upon the patients; but in most cases the current, if incoming, is really carried a good way above the beds, and generally the complaint is more imaginary than real. But, as we have seen that outgoing currents are not infrequent, it is possible that air may blow over the patients as it rushes to the tube. It seems also to have been difficult to keep up the temperature in winter without closing some of the tubes, a practice which ought to be resorted to as little as possible.

III. With regard to what may be done for the further improvement of the Hospital, I would point out one or two things :—

1. The ventilators ought to be most carefully and continually inspected, to see that they are not blocked up. I found in one a bundle of newspaper and an old flannel jacket, which had been thrust in and the top grating put on again, so that nothing would have been suspected had the absence of current not excited suspicion. No discretion as to closing a ventilator ought to be left to either sister or patient. I understand the Registrar undertakes the duty at present. The question of temperature is one of some difficulty in winter; but if 60° can be maintained it is probably enough, or even 57° or 58° in Surgical Wards. With a lower temperature, however, the difficulty of keeping the air sufficiently dry is much increased. At

the same time, it cannot be too frequently repeated, that lowering of temperature (except, of course, in extremes) is much less dangerous than fouling of air, and that it is most imprudent (to say the least) to sacrifice freshness to temperature. If, on the other hand, it be found impossible to keep the Wards at a fair temperature with a proper amount of ventilation, then it will be necessary to warm the incoming air during the colder months of the year.

2. Especial care should be taken to prevent accumulation of dust in the Wards. The microscopical observations show the importance of this.

I may here observe that there does not seem to be any provision for arresting the dust in the ventilating tubes, or for cleaning them out when foul.

3. All the openings in the walls of the Wards to Lobbies, &c., have not been bricked up; I think this ought to be done throughout.

4. It seems undesirable to have fires burning in the Wards during hot summer nights. A single Bunsen burner would keep a sufficient quantity of water hot for all purposes; whilst the practice of drying things before the fire cannot be too strongly reprehended.

5. Special attention should be given to the regular emptying of the dust or ash-pit behind; this should be done daily if possible, but not less frequently than every two days.

For other points, such as the position of the laundry, the making the walls and floors impervious, &c., I would refer to my previous Reports.

IV.—With regard to the surroundings of the Hospital, it would, of course, be highly advantageous could some of the buildings which press more immediately upon it be removed. This, however, is a question of expense, and it may not be possible to entertain it. I think, however, there is a good case for remonstrance against the continued existence of the great dust-yard near the Canal basin. Such an accumulation in the neighbourhood of habitations is at all times objectionable, and particularly in proximity to an Hospital. There seems good reason to believe that it is the cause of the unpleasant smell perceived in "Thistlethwayte" Ward, which is more particularly exposed to its influence.

F. DE CHAUMONT, M.D.,

Professor of Hygiene, Army Medical School.

September 13*th*, 1876.

ry's Hospital, Paddington, W. TABLE IV. M

W.

	oria.	Cambridge	Manvers.	Thistlethwayte.	South-east side [Windward.]		North-west si [Leeward.]		
	an.	Mean.	Mean.	Mean.	Centre.	Window.	Centre.	Wind	
	°3	75°7	75°0	74°3	78°7	ditto	ditto	dit	
	9°3	68°8	67°0	69°0	71°6	,,	,,	,	
Place	·3°7	63°9	61°2	65°1	66°7	,,	,,	,	
Hour	·5·4	6·4	5·8	6·7	7·0	,,	,,	,	ernal ir. p.m.
Meteorological Observations. Baro	·7	3·2	3·6	2·4	3·5	,,	,,	,	
Temperature.	3	66	62	73	67	,,	,,	,	920 °0 °9 °0
Vapour. resh	il	nil	nil	nil	nil	,,	,,	,	
y	6	12	14	18					
	6	11	14	17					·3
	78	2273	2357	2035					·5
Wind						N.B.—	These	are	
Ditto	335	0·662	0·621	0·630	0·801	0·750	1·127	0·8	3
Ozone	416	0·416	0·416	0·416	0·428	0·428	0·428	0·4	W.
Weat									erate
Beds Tot									il
Oc	417	0·246	0·205	0·214	0·373	0·322	0.699	0·3	east
Floor spac									168
Cubic spac per head									to
Carbonic	45	2440	2825	2810	1610	1865	860	15	
Acid per	70	1·08	1·20	1·43	0·66	0 77	0·35	0·	
1000	6¾	26	28¾	34¼	16	18¼	8½	15	
volumes.	497	nil	0·0310	0·0127	0·0100				
Air suppl	522	0·2824	0·3576	0·5259	0·3684				
per hou from th									
Impurit	321	0·5142	0·4142	0·4451	0·6315				
Times air changed	747	0·2571	0·3101	0 2225	0·4420				
Air measu	387	0·7392	0·3567	0·6398	0·5447				
tilators	52	28·4840	13·8070	25·4780	17·8072				
	160	751·960	748·060	738·140	738·970				

.—The quantities under Nitric Acid include really all the N

EXPERIMENTS at St. Mary's Hospital, Paddington, W. TABLE I. 15th August, 1876.

Place	External Air.			"Victoria."			"Cambridge."			"Manvers."			"Thistlethwayte."			"Accident."			Mean of Wards
Hour	5 p.m.	10 p.m.	Mean.	4 p.m.	mid-night.	Mean.	5·30 p.m.	11 p.m.	Mean.	7 p.m.	11·30 p.m.	Mean.	6 p.m.	10·30 p.m.	Mean.	4·30 p.m.	10 p.m.	Mean.	
Meteorological Observations. Barometer	29·900	29·900	29·900																
Temperature. Dry Bulb	84°0	79°0	81°5	81°0	79°0	80°0	80°	80°	80°	79°9	80°0	79°95	80°0	78°0	79°0	82°0	78°0	80°0	80°6
Wet ditto	70°0	68°0	69°0	70°0	70°0	70°0	70°	70°	70°	75°5	76°0	75°75	70°5	69°0	69°75	70°5	71°0	70°75	71°3
Dewpoint	60°8	60°4	60°6	62°6	63°8	63°2	63°2	63°2	6°32	72°5	73°3	72°80	62°7	62°7	62°5	62°7	66°1	64°5	65°0
Vapour. Vapour in a cubic foot of air	5·6	5·6	5·6	6·0	6·4	6·2	6·2	6·2	6·2	8·6	8·8	8·7	6·1	6·2	6·1	6·1	6·9	6·5	6·6
Vapour required to saturate ditto	6.8	5·0	5·8	5·3	4·2	4·8	4·8	4·8	4·8	2·4	2·2	2·3	6.6	4·1	4·5	5·6	3·4	4·5	4·6
Humidity per cent	45	53	49	53	59	56	56	56	56	79	80	80	52	59	57	52	67	58	58
Wind, direction	E	E	E																
Ditto, force	moderate	moderate	moderate																
Ozone	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	
Weather	hot	and	dry																
Beds Total				16	16	16	12	12	12	14	14	14	18	18	18	18	18	18	
Beds Occupied				15	15	15	11	11	11	all	all	all	17	17	17	15	15	15	
Floor space per head																			
Cubic space per head Total																			
Cubic space per head Effective				2210	2210	2210	2250	2250	2250	2383	2383	2383	2150	2150	2150	2620	2620	2620	about 2300
Carbonic Acid per 1000 volumes. Total	0·298	0·648	0·475	0·519	0·717	0·618	0·702	0·794	0·748	0·660	0·520	0·590	0·476	0·722	0·599	0·569	0·612	0·590	0·629
Outer air	ditto	ditto	ditto	0·298	0·648	0·475	0·298	0 648	0·475	0·298	0·648	0·575	0.298	0·648	0·475	0·298	0·648	0·475	0·475
Respiratory Impurity				0·221	0·069	0·143	0·404	0·146	0·273	0·362	?	0·115	0·178	0·074	0·124	0·271	0·071	0·115	0·154
Air supplied per head per hour, calculated from the Respiratory Impurity				2720	8700	4260	1495	4210	2200	1660	∞ ?	5220	3370	8140	4860	2220	8450	5·230	3810
Times air changed Per hour				1·23	3·94	1.93	0.71	1·88	0·98	0·70	∞ ?	2·19	1·55	3·80	2·26	0·85	3·20	2·00	1·66
In 24 hours				29½	95	46½	17	45	23¾	16¾	∞ ?	53	37½	91½	54	20½	77	48	40
Air measured by Ventilators	See body	of Report																	

EXPERIMENTS at St. Mary's Hospital, Paddington, W. TABLE II. August 16th, 1876.

Place	External Air.			Victoria	Cambridge	Manvers	Thistlethwayte	Accident Ward.									Foresters 10 p.m.			Mean of Wards.
								North-west side (Leeward.)		South-east side (Windward.)										
Hour	Roof 6 p.m.	Ground 1 a.m. (17th.)	Mean.	11 p.m.	0·30 a.m. (17th)	11 p.m.	Midnight.	Centre	window	Centre	window	Mean Centre	Mean window	Mean windward	Mean leeward	Mean of Ward.	opposite end (Wd.)	near bad case (Ld.)	Mean of Ward.	
Meteorological Observations. Barometer	29·920	29·900	29·910																	
Temperature. Dry Bulb	70°0	67°2	68°6	78°0	75°9	73°0	72°0	78°0	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	77°0	ditto	ditto	76°0
Wet ditto	61°2	60°0	60°6	69°0	68°5	67°0	68°0	71°9	,,	,,	,,	,,	,,	,,	,,	,,	70°0	,,	,,	69°1
Dewpoint	54°4	54°3	54°3	62°7	63°2	62°6	65°0	67°6	,,	,,	,,	,,	,,	,,	,,	,,	65°1	,,	,,	64°2
Vapour. Vapour in a cubic foot of air	4·7	4·7	4·6	6·2	6·3	6·2	6·7	7·3	,,	,,	,,	,,	,,	,,	,,	,,	6·7	,,	,,	6·4
Vapour required to saturate ditto	3·3	2·5	3·1	4·1	3·7	2·6	1·8	3·4	,,	,,	,,	,,	,,	,,	,,	,,	3·3	,,	,,	3·3
Humidity per cent	58	63	60	59	64	70	79	67	,,	,,	,,	,,	,,	,,	,,	,,	67	,,	,,	67
Wind, direction	S.E.	S.E.	S.E.																	
Ditto, force	moderate	moderate	moderate																	
Ozone	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	
Weather	dry	and	fine																	
Beds Total				16	12	14	18									18			12	
Beds Occupied				16	11	14	17									16			12	
Total cubic space per head				2077	2273	2357	2035									2438			2230	
Carbonic Acid per 1000 volumes. Total	0·528	0·361	0·444	1·309	0·572	0·703	0·727	1·289	0·646	0·721	0·709	1013	0·677	0·716	0·970	0·842	0·751	1·354	1·112	0·877
Outer air	ditto	ditto	ditto	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444	0·444
Respiratory Impurity				0·865	0·128	0·259	0·283	0·845	0·202	0·277	0·265	0·569	0·233	0·272	0·526	0·398	0·307	0·910	0·668	0·433
Air supplied per head per hour, calculated from the respiratory impurity				695	4700	2320	2120	720	2960	2160	2270	1060	2580	2210	1145	1515	1960	660	905	1390
Times air changed Per hour				0·33	2·08	0·97	0·92	0·29	1·22	0·88	0·93	0·43	1·06	0·90	0·47	0·62	0·87	0·30	0·41	0·60
In 24 hours				8	50	23	22	7	29½	21	22½	10	25½	21½	11	15	21	7	10	14½

EXPERIMENTS at St. Mary's Hospital, Paddington, W. Table III. August 17th, 1876.

Place	External Air.	Victoria	Cambridge.	Manvers.	Thistlethwayte.	Accident Ward. 10 p.m.									Foresters. 10 p.m.			Operating Theatre.	Mean of Wards.
Hour	11 p.m.	7 p.m.	8-30 p.m.	7-30 p.m.	8 p.m.	South-east side [Windward.]		North-west side [Leeward.]		Mean Centre	Mean Window	Mean Windward.	Mean Leeward.	Mean of Ward.	Opposite end [Wind.]	Near bad case [Lee.]	Mean of Ward.	9 p.m.	
						Centre	Window	Centre	Window										
Meteorological Observations. Barometer	29·820																		
Temperature. Dry Bulb	68°0	74°0	71°2	72°0	71°9	78°0	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	77°0	ditto	ditto	95°0	74°0
Temperature. Wet ditto	62°0	69°0	68°0	68°2	69°4	72°0	,,	,,	,,	,,	,,	,,	,,	,,	72°0	,,	,,	76°0	69°8
Temperature. Dewpoint	57°3	65°3	65°5	65°3	67°5	67°8	,,	,,	,,	,,	,,	,,	,,	,,	68°5	,,	,,	64°6	66°7
Vapour. Vapour in a cubic foot of air	5·2	6·8	6·9	6·8	7·3	7·3	,,	,,	,,	,,	,,	,,	,,	,,	7·5	,,	,,	6·3	7·1
Vapour. Vapour required to saturate ditto	2·3	2·3	1·5	1·7	1·2	3·0	,,	,,	,,	,,	,,	,,	,,	,,	2·5	,,	,,	10·9	2·0
Vapour. Humidity per cent.	68	74	82	80	86	71	,,	,,	,,	,,	,,	,,	,,	,,	75	,,	,,	37	78
Wind, direction	S.E.																		
Ditto, force	Fresh																		
Ozone	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil
Weather	dry and warm																		
Beds. Total		16	12	14	18									18	12				
Beds. Occupied		14	11	14	17									16	12				
Total cubic space per head		2380	2273	2357	2035									2438	2230				about 2300
Carbonic Acid per 1000 volumes. Total	0·312	0·577	0·671	0·571	0·564	0·881	0·792	0·965	0·978	0·923	0·882	0·836	0·971	0·903	0·926	1·049	0·979	2·018	0·711
Carbonic Acid per 1000 volumes. Outer air	ditto	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312	0·312
Carbonic Acid per 1000 volumes. Respiratory Impurity		0·265	0·359	0·259	0·252	0·569	0·480	0·653	0·666	0·611	0·570	0·524	0·659	0·591	0·614	0·737	0·667	1·706	0·399
Air supplied per head per hour, calculated from the respiratory Impurity		2270	1680	2320	2380	1060	1260	920	905	980	1060	1145	915	1015	975	820	900	352 ?	1510
Times air changed. Per hour		0·95	0·70	0·97	1·04	0·43	0·51	0·37	0·37	0·40	0·43	0·47	0·39	0·42	0·44	0·37	0·40		0·66
Times air changed. In 24 hours		23	17	23	25	10	12	9	9	9½	10	11	9¼	10	10½	9	9½		17

EXPERIMENTS at St. Mary's Hospital, Paddington, W. TABLE IV. Means of Observations, August 15th, 16th & 17th, 1876.

Place	External Air.	Victoria.	Cambridge	Manvers.	Thistlethwayte.	Accident Ward.									Foresters.			Wards.
						South-east side [Windward.]		North-west side [Leeward.]		Mean Centre.	Mean Window.	Mean Wind-ward.	Mean Leeward.	Mean of Ward.	opposite end.	near bad case.	Ward.	General Mean.
Hour	Mean.	Mean.	Mean.	Mean.	Mean.	Centre.	Window.	Centre.	Window.									
Meteorological Observations. Barometer . . .	29·887																	
Temperature. Dry Bulb .	71°8	77°3	75°7	75°0	74°3	78°7	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto	77°0	ditto	ditto	76°3
Wet ditto .	62°8	69°3	68°8	67°0	69°0	71°6	„	„	„	„	„	„	„	„	71°0	„	„	69°4
Dewpoint .	56°0	63°7	63°9	61°2	65°1	66°7	„	„	„	„	„	„	„	„	66°8	„	„	64°5
Vapour. Vapour in a cubic foot of air . . .	5·0	6·4	6·4	5·8	6·7	7·0	„	„	„	„	„	„	„	„	7·1	„	„	6·5
Vapour required to saturate ditto .	3·5	3·7	3·2	3·6	2·4	3·5	„	„	„	„	„	„	„	„	2·9	„	„	3·3
Humidity per cent . .	58	63	66	62	73	67	„	„	„	„	„	„	„	„	71	„	„	67
Wind, direction .	S.E by E																	
Ditto, force . . .	moderate	to fresh																
Ozone	nil	nil	nil	nil	nil	nil	„	„	„	„	„	„	„	„	nil	„	„	nil
Weather	fine and	dry																
Beds { Total		16	12	14	18									18	12			
Occupied . . .		16	11	14	17									16	12			
Total cubic space per head		2078	2273	2357	2035									2438	2230			2235
	Total of all Ward Observations						N.B.—	These	are the	means	of the	16th	and	17th	only.			
Carbonic Acid per 1000 volumes. Total . . .	0·400	0·835	0·662	0·621	0·630	0·801	0·750	1·127	0·812	0·968	0·779	0·776	0·970	0·872	0·838	1·201	1·045	0·762
Outer air . .	0·416	0·416	0·416	0·416	0·416	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·416
Respiratory Impurity .	Accident details, and Foresters 0·428	0·417	0·246	0·205	0·214	0·373	0·322	0.699	0·384	0·540	0·351	0·348	0·542	0·444	0·410	0·773	0·619	0·346
Air supplied per head per hour, calculated from the Respiratory Impurity		1445	2440	2825	2810	1610	1865	860	1565	1135	1710	1725	1110	1355	1470	780	975	1740
Times air changed { Per hour .		0·70	1·08	1·20	1·43	0·66	0·77	0·35	0·65	0·46	0·71	0·71	0·46	0·55	0·61	0·35	0·44	0·78
In 24 hours		16¾	26	28¾	34½	16	18¼	8½	15½	11	17	17	11	13¼	16	8½	10½	19
In milligrammes per cubic metre. Ammonia, free .	0·0163	0·0497	nil	0·0310	0·0127	0·0100					Means	of the	three	nights.				0·0207
Ditto, albuminoid	0·5206	0·4622	0·2824	0·3576	0·5259	0·3684				Total, CO_2 .		0·721	0·837	0·778				0·3993
Oxygen required for total oxidisable matter. .	0·5714	0·5621	0·5142	0·4142	0·4451	0·6315				Outer Air, CO_2 . . .		0·416	0·416	0·416			Ammo-	0·5174
Ditto, for Organic matter only .	0·4444	0·3747	0·2571	0·3101	0 2225	0·4420				Respiratory Impurity . .		0·305	0·421	0·362			nias,	
Nitrous Acid . .	0·3651	0·5387	0·7392	0·3567	0·6398	0·5447				Air supplied .		1970	1425	1660			&c.	0·3213
Nitric Acid . .	6·3923	5·0052	28·4840	13·8070	25·4780	17·8072				*Times Air changed:—*								0·5638
										Per hour . .		0·81	0·58	0·68				18·1163
Air passed through Aspirators (in litres) .	735·060	747·160	751·960	748·060	738·140	738·970				In 24 hours .		19½	14	17				745

N.B.—The quantities under Nitric Acid include really all the Nitrogen Acids. See body of Report.

[M]eans of Observations, August 15th, 16th & 17th, 1876.

Accident Ward.						Foresters.			Wards.
ow.	Mean Centre.	Mean Window.	Mean Windward.	Mean Leeward.	Mean of Ward.	opposite end.	near bad case.	Ward.	General Mean.
to	ditto	ditto	ditto	ditto	ditto	77°0	ditto	ditto	76°3
	,,	,,	,,	,,	,,	71°0	,,	,,	69°4
	,,	,,	,,	,,	,,	66°8	,,	,,	64°5
	,,	,,	,,	,,	,,	7·1	,,	,,	6·5
	,,	,,	,,	,,	,,	2·9	,,	,,	3·3
	,,	,,	,,	,,	,,	71	,,	,,	67
	,,	,,	,,	,,	,,	nil	,,	,,	nil
					18	12			
					16	12			
					2438	2230			2235
the	means	of the	16th	and	17th	only.			
12	0·968	0·779	0·776	0·970	0·872	0·838	1·201	1·045	0·762
28	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·428	0·416
34	0·540	0·351	0·348	0·542	0·444	0·410	0·773	0·619	0·346
55	1135	1710	1725	1110	1355	1470	780	975	1740
5	0·46	0·71	0·71	0·46	0·55	0·61	0·35	0·44	0·78
½	11	17	17	11	13¼	16	8½	10½	19
		Means	of the	three	nights.				0·0207
	Total, CO_2 .		0·721	0·837	0·778				0·3993
	Outer Air, CO_2 . . .		0·416	0·416	0·416				
	Respiratory Impurity . .		0·305	0·421	0·362			Ammo-	0·5174
	Air supplied .		1970	1425	1660			nias, &c.	0·3213
	Times Air changed:—								0·5638
									18·1163
	Per hour . .		0·81	0·58	0·68				
	In 24 hours .		19½	14	17				745

Nitrogen Acids. See body of Report.

EXPERIMENTS at St. Mary's Hospital, Paddington, W.

TABLE V. 18th August, 1876.

Place	Central Hall and Staircase. 10 p.m.				External Air. 10 p.m.
Floor	Ground	1st floor.	2nd floor.	Mean.	
Meteorological Observations. Barometer . . .					29·920
Temperature. Dry Bulb .	69°8	71°4	71°6	70°9	69°0
Temperature. Wet ditto .	65°4	69°0	69°0	67°8	67°9
Temperature. Dewpoint .	62°0	67°2	67°0	65°3	67°0
Vapour. Vapour in a cubic foot of air . . .	6·1	7·2	7·2	6·8	7·3
Vapour. Vapour required to saturate ditto .	1·7	1·2	1·2	1·4	0·5
Vapour. Humidity per cent . .	76	86	85	82	93
Wind, direction .					S.W.
Ditto, force . . .					moderate
Ozone	nil	nil	nil	nil	nil
Weather					overcast
Carbonic Acid per 1000 volumes. Total . . .	0·238	0·456	0·500	0·394	0·368
Carbonic Acid per 1000 volumes. Outer air . .	0·368	0·368	0·368	0·368	ditto
Carbonic Acid per 1000 volumes. Respiratory Impurity .	?	0·088	0·132	0·026	
Air supplied per head per hour, calculated from the respiratory impurity	∞ ?	6840	4550	23100	

EXPLANATION OF DRAWINGS.

(15 Plates.)

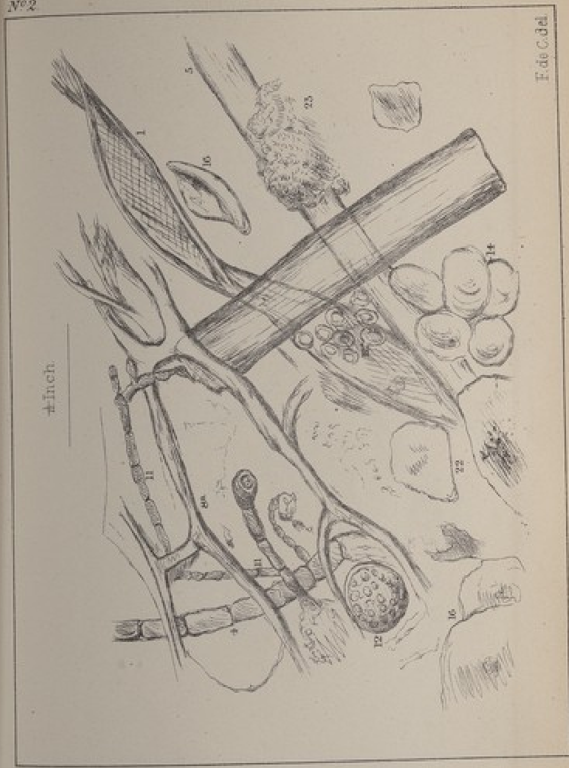
1. Cotton.
2. Linen.
   2A. Worn fibre of linen.
3. Wool.
4. Silk.
5. Hair (chiefly human).
6. Down.
7. Straw (wheaten).
8. ,, (barley.)
   8A. Cellulose, perhaps from Beans.
9. Pitted tissue of wood (deal)
10. Hairs (vegetable).
11. Fungi.
12. Granular bodies, probably spores.
   12A. Cellular bodies, propably ova.
13. Mycelium of fungi.
14. Starch (chiefly wheaten).
15. Epithelium (skin).
16. ,, (mouth).
17. Infusoria (monas lens, pleuromonas, &c.)
18. Sarcoptes scabiei, (itch insect), larval form.
19. Scales of insects (gnat).
20. Sand.
21. Soot, or charred wood.
22. Pellicles of doubtful origin.
23. Granular matter.
24. Doubtful.
25. Bacteria.
26. Vegetable structures (various).
27. Crystalline substance (doubtful).

N.B.—The numbers refer to *all* the drawings.

No 1

OUTER AIR.

No. 2.

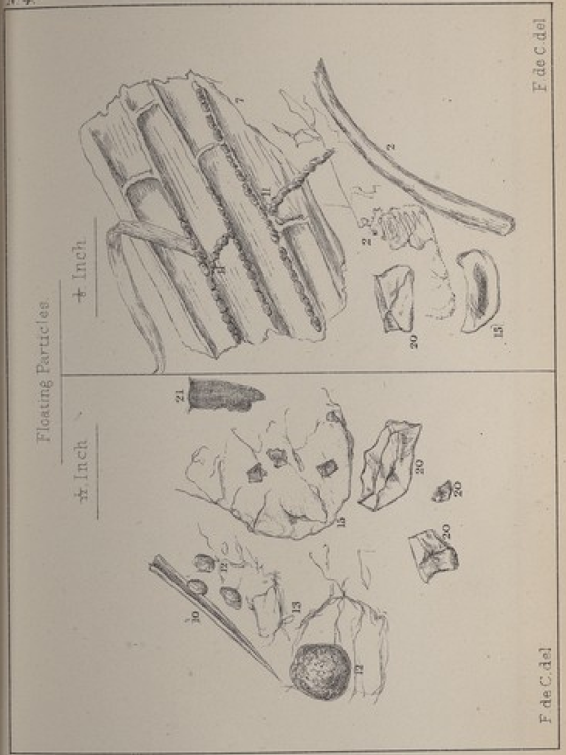


Dust * Inch.

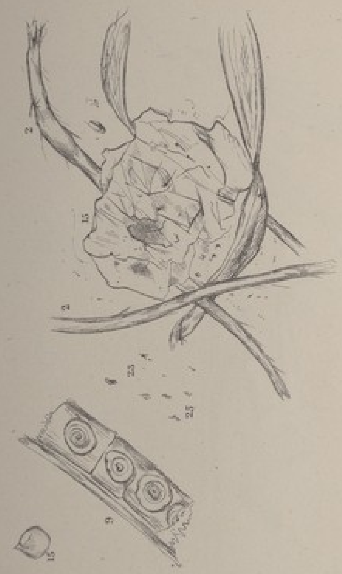
F de C. del.

No 4.

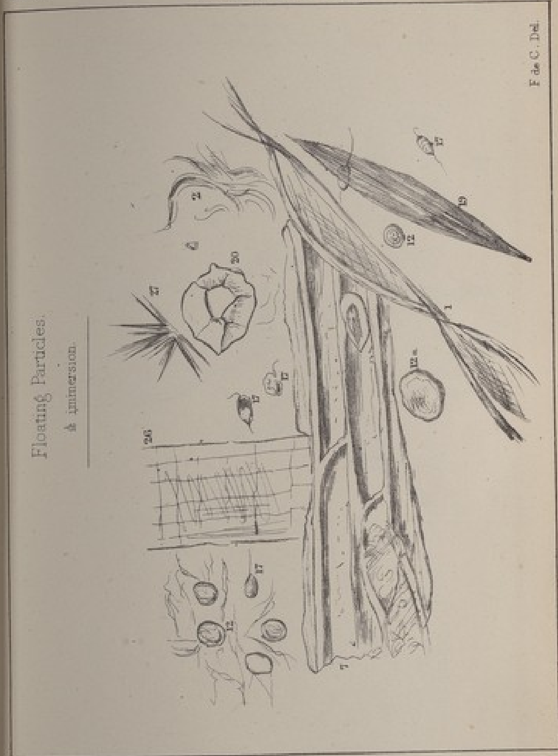
VICTORIA.

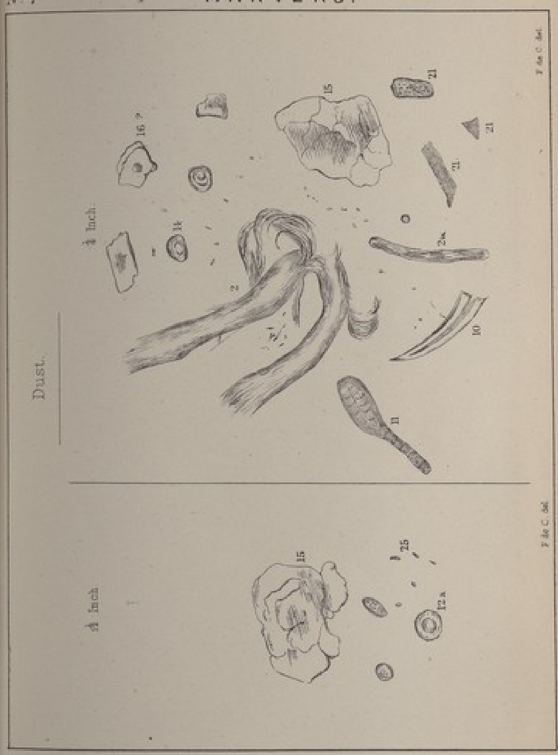


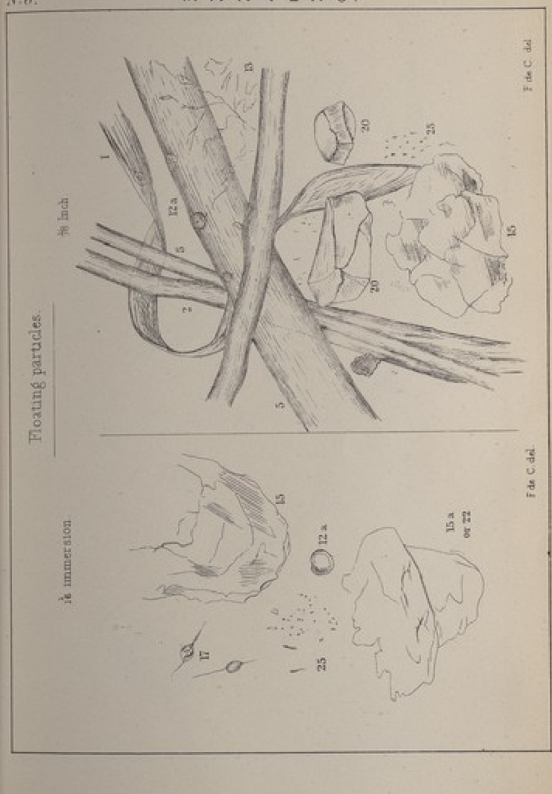
F. de C. Del.



Dust.
$\frac{1}{4}$ inch.

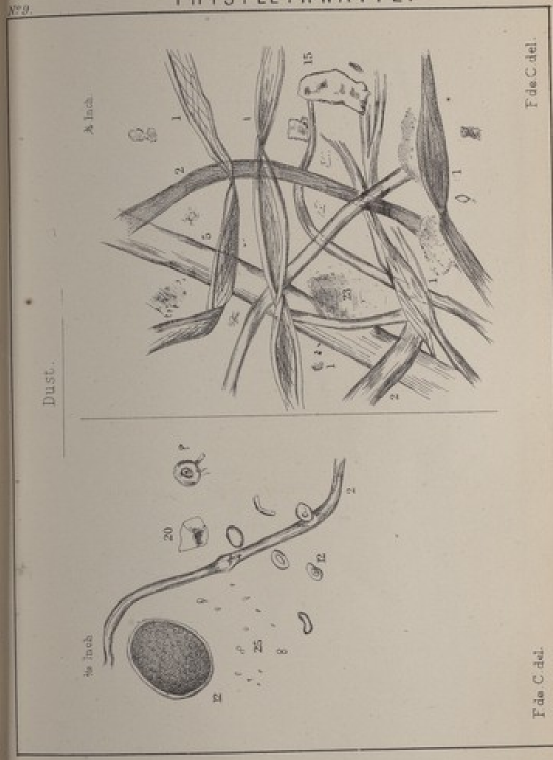

Floating Particles.
⅛ immersion.
F. de C. Del.

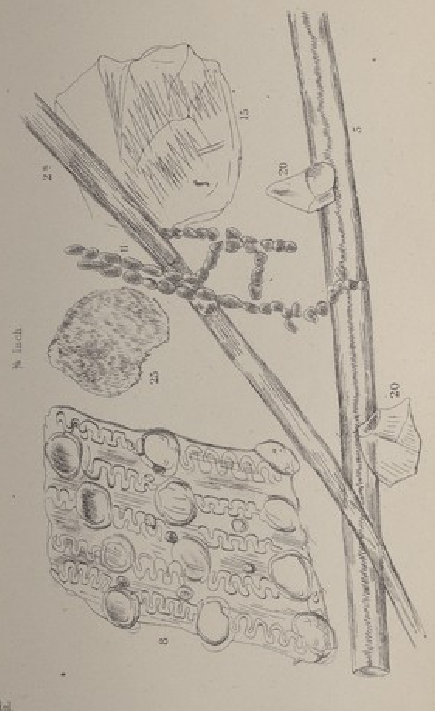

Dust.



Floating particles.
⅛ Inch
1⁄16 immersion.
F de C. del.
F de C. del.

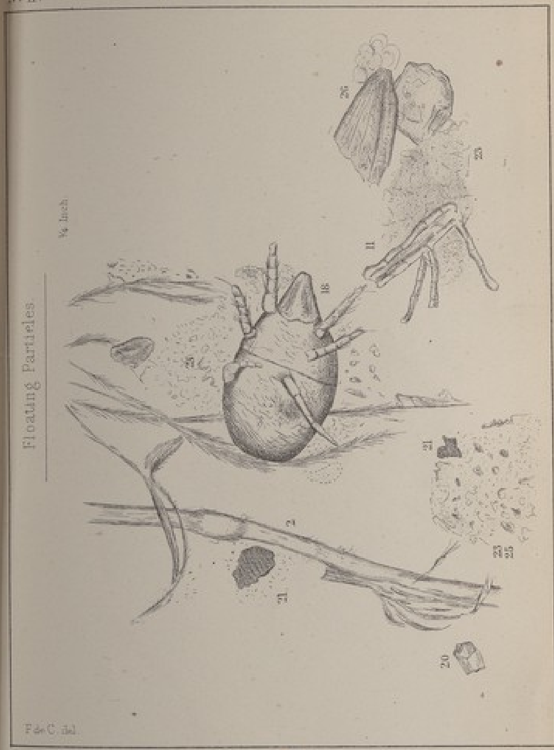
No 9. THISTLETHWAYTE.



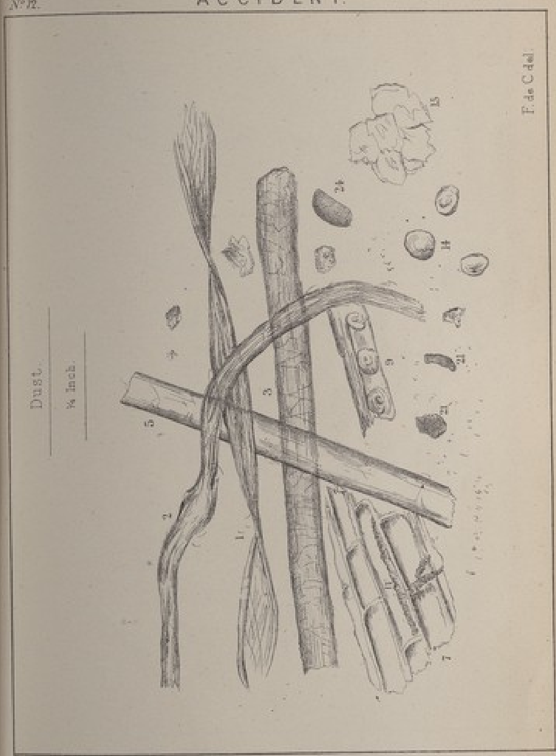


Floating Particles

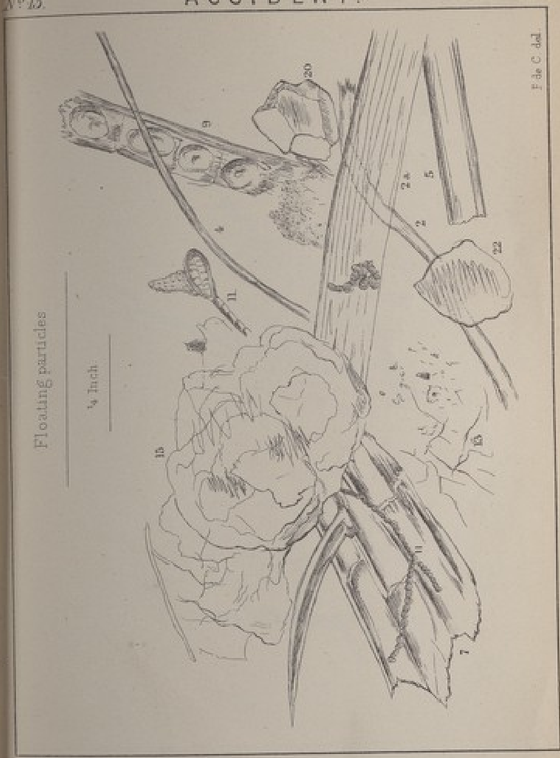
F de C. del.


Floating Particles
¼ Inch
F de C. del.

No 12. ACCIDENT.



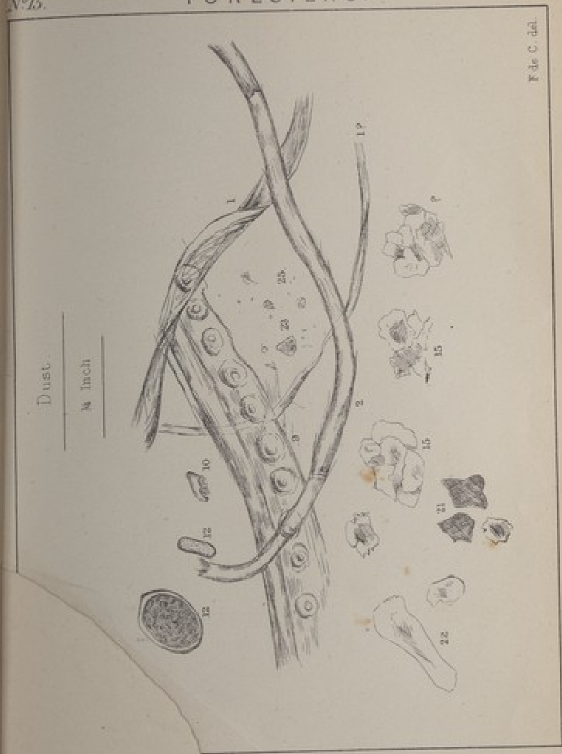
No 13. ACCIDENT.



Floating particles.

⅛ immersion.

No 15. FORESTERS.



MAGISTRATES AND COUNCIL (POLICE).

REPORT BY THE MEDICAL OFFICER

ON

OUTBREAK OF ENTERIC FEVER

IN

ROYAL AND WESTERN INFIRMARIES,

AND

FEVER HOSPITAL, BELVIDERE,

GLASGOW,

IN AUGUST, 1884.

18th September, 1884.

GLASGOW:
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REPORT BY THE MEDICAL OFFICER ON OUTBREAK OF ENTERIC FEVER IN GLASGOW ROYAL AND WESTERN INFIRMARIES AND FEVER HOSPITAL IN AUGUST, 1884.

IN the last days of August, 1884, the Superintendent of the Western Infirmary observed among his staff several cases of febrile sickness, and received reports from the resident assistants of unaccountable elevation of temperature among the patients under treatment in the wards. By 1st September some of these cases had developed into undoubted enteric fever, and he put himself into communication with me. In such circumstances the first thing to be done is, from a rapid survey of the facts, to determine a course of preventive action. On tabulating the cases of sickness, decided as well as suspicious, but all more or less febrile, they were found to exist both among patients and the female staff, not confined to any ward or department of the house, and yet from the dates of seizure to clearly indicate the operation of some medium of infection becoming suddenly active, and having access to the inmates generally. There were no cases of enteric fever under treatment in the wards. In the history of the Hospital only one case of enteric fever had ever originated in the house, and that was some years ago, in the person of a nurse who was in attendance upon an isolated case which had been admitted as a patient. Of the known media for the spread of the fever, there was only one which brought all the cases within the range of its influence, and that was the milk supply. Water in Glasgow may always be set to one side as an epidemic agent. It was scarcely conceivable that in a newly-erected hospital, the drainage of which had been carefully planned and tested, any derangement of such extent and gravity as to impregnate the whole building with specific effluvia, and yet have escaped the observation of the senses, could exist. Still, to set that doubt at rest, as well as to make sure that the specific poison, however introduced, should not spread secondarily by any defects in drains or soil-pipes, the whole system was carefully examined with the smoke test by the officers of the department. Only a few insignificant defects were discovered. As regards the question at issue it was clear that the medium of infection did not exist in that direction. The Superintendent gave orders that all milk should be boiled before use. Application was made to the milk-contractor for a list of the farmers from whom he obtained his supply. A long experience in such inquiries has taught me that in the distribution of the milk consigned to a milk-dealer, while he may correctly state from what sources individual customers are *usually* supplied, there is no certainty that these sources are always the same. On Sundays, from the stoppage of trained milk, there must be a deviation from the system which prevails during the week, and in general from a variety of causes, there is so much chance of variation and intermixture that portions of any one farmer's milk may, especially in the afternoon delivery, find their way to any customer at one time or another. The practical result of this system of business is that in any investigation for a contaminated source, while it is well to follow up first such indications as the agent can give, nothing short of an examination of every farm on his list is satisfactory. In the present case there were 40 farms in the list supplied, scattered over the counties of Stirling, Dumbarton, Lanark, Renfrew, Ayr, and Wigtown. A circular letter was at once issued to each one enquiring as to the health of the farmer's household, his employés and their families, and the cattle, since the 1st of June, and at the date of reply. At the same time an inspection by the milk inspectors was begun, and I went in person to the three farms designated as the chief source of the hospital supply. In this way seven farms were visited in Renfrewshire and Ayrshire without result.

Meanwhile I knew that the milk supply of the Royal Infirmary and Belvidere Hospital was from the same agent. I heard from Belvidere that a nurse who had been sent from the Royal Infirmary as a case of scarlet fever was found to be suffering from enteric fever, and that she had sickened at the same time as the Western

Infirmary cases. On visiting the Royal Infirmary I found that the Superintendent and visiting staff were also becoming aware of a febrile outbreak in their wards and among the female employés; and, in fact, had decided that some of the cases were examples of enteric fever. By the end of the week (6th September) Dr. Allan had also made out a similar outbreak among his scarlet fever patients. The case against the milk had now become a certainty. We had three coincident outbreaks of enteric fever among the patients and officials of three institutions, situated one at the extreme west, another at the extreme east, and the third intermediate, in the extreme north of the city, isolated as to locality, as to sewers, and related only in the use of a common water supply and a common milk supply. The city generally showed no signs of a similar epidemic influence. There had been evidence of the commencement of the usual sporadic autumnal increase of enteric fever, but there is the same difference between the scattered, irregular appearance of such cases and the condensed, contemporaneous local outburst of epidemics, as there is between the weeds by the wayside and the field of grain. The former suggest nothing but a series of disconnected accidents, the latter carries conviction to the mind of the observer that there has been one act of sowing.

Before stating the discovery to which the investigation, which was dictated by these facts and this line of reasoning, led up to, I shall, in accurate detail, give an account of the main features of the three outbreaks of enteric fever up to yesterday, the 17th September. Just as the diagnosis of an individual case of fever is strengthened by the progress of the case, so my argument as to the nature and origin of these local epidemics derives, or ought to derive, increased conclusiveness from a survey of their characteristics now, when they have run the main part of their course. The basement fact in reference to the causation of a case of fever is to determine the date when the patient sickened. The basement fact in reference to the causation of a series of cases is the coincidence of the dates of sickening of the individual cases in the series.

I have obtained from the Superintendent of each Institution a return of the cases originating in the institution from 1st August. These are arranged according to the date of sickening in the following table which shows the number who fell sick each day from that date to the 17th September.

DATES OF SICKENING IN THE THREE INSTITUTIONS.

	AUGUST.												SEPTEMBER.																				Total
	20	21	22	Sat. 23	24	25	26	27	28	29	Sat. 30	31	1	2	3	4	5	Sat. 6	7	8	9	10	11	12	Sat. 13	14	15	16	17	18	19	20	
Western Infirmary.																																	
Daily, ...	...	...	...	1	...	1	4	1	4	2	1	1	5	1	5	1	1	4	2	3	1	2	2	2	...	...	...	...	...	...	...	...	...
Weekly, ...	...	...	...	1	...	...	...	13	...	...	...	...	...	...	18	...	...	...	...	...	...	12	...	...	...	...	...	...	...	...	...	...	44
Belvidere.																																	
Daily, ...	...	...	...	...	1	...	4	1	3	1	...	4	3	1	3	...	...	2	6	2	...	...	...	...	...	...	...	...	...	...	...	...	...
Weekly, ...	...	...	...	...	...	...	...	10	...	...	...	...	...	...	13	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...	...	31
Royal Infirmary.																																	
Daily, ...	...	...	...	...	...	2	1	1	3	1	2	3	4	...	1	1	...	2	1	5	...	1	1	...	...	...	...	...	...	...	...	...	...
Weekly, ...	...	...	...	...	...	...	...	10	...	...	...	...	...	...	11	...	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...	...	29
Total.																																	
Daily, ...	...	...	...	1	1	3	9	3	10	4	3	8	12	2	9	2	1	8	9	10	1	3	3	2	...	...	...	...	...	...	...	...	...
Weekly, ...	...	...	...	1	...	...	...	33	...	...	...	...	...	...	42	...	...	...	...	...	...	28	...	...	...	...	...	...	...	...	...	...	104

Milk stopped on 6th September.

When you look at this table it will compel your reason to the conclusion that by some common agency the specific seeds of enteric, fever were sown in these institutions at the same time. The mere looking at it and comprehension of it is all that is necessary but I shall shortly write out what this table tells. In the first 22 days of August no fever originated in those institutions, although in the case of the Royal Infirmary several cases admitted from without were under treatment, and in the case of Belvidere, it is a fever hospital, and has enteric wards. On the 23rd the first case sickened in the Western Infirmary—a servant employed in the kitchen; on the 24th the first case sickened in Belvidere—a mother nursing her child in a measles ward; on the 25th the first cases sickened in the Royal Infirmary—a patient in surgical ward 23, and another in medical ward 4. The 23rd August was a Saturday, and, taking the natural weeks thereafter, the subsequent development in these Institutions was:—In the week ending 30th August—13 cases in the Western Infirmary, 10 in Belvidere, and 10 in the Royal; in the week ending 6th September—18 in the Western Infirmary, 13 in Belvidere, and 11 in the Royal; in the week ending 13th September—12 in the Western Infirmary, 8 in Belvidere, and 8 in the Royal. The last cases appeared on the 12th September in the Western Infirmary; on the 8th September at Belvidere; and on the 11th September in the Royal. So much for the coincidence in time. The following facts show how general within each institution has been the distribution of the specific poison. In the Western Infirmary 26 patients have been infected, 7 nurses, 7 cleaners, 1 kitchen porter, 1 boy employed in the laboratory, 1 servant, and 1 house physician—44 in all. The patients are scattered over 15 wards, medical and surgical; the officials are also in their employment distributed over the house. At Belvidere, 24 patients were infected, 3 nurses, 2 nursing mothers, 1 cleaner, and 1 lady who made a short visit to the matron—31 in all. Of the patients, 20 were under treatment for scarlet fever, 3 for measles, and 1 for typhus. One of the nursing mothers was in a scarlet fever, another in a measles ward. Of the nurses, 2 were in scarlet fever wards, and 1 in a measles ward. The cleaner was in a measles ward. In the Royal Infirmary 26 patients were infected, 2 nurses, and 1 cleaner—29 in all. The patients were scattered about the house, but chiefly surgical, there being generally fully a half more surgical than medical inmates. The nurses were employed, 1 in the erysipelas, the other in a surgical ward. All these persons had milk. The Western Infirmary nurses get sweet milk only. The convalescent patients get skim milk with porridge. The resident physician drank cold sweet milk largely to lunch and supper, and never took porridge. The first person who was seized in the Western drank cold milk "in large quantity." The kitchen porter lives and boards outside, but admits having drank milk in the kitchen. So did the laboratory boy. One of the worst cases is a nurse who was on milk diet for indigestion. These examples of the incidence of the fever on special milk-consumers could be multiplied from the other Institutions. I ought to add that only undoubted cases are included in this statement; but in each Institution there has been a fringe of cases of a febrile nature, which aborted, but were no doubt also specific in their origin. The total number of cases so far is 104. The average number of patients and officials in August was—in the Western Infirmary, 450; at Belvidere, 475; in the Royal, 624. The proportion of cases so far has therefore been twice as great in the Western as in the Royal. An outbreak in the entire community proportionate to that among this hospital population of 1,549 would imply between 30,000 and 40,000 cases! But it will never be accurately known how much mischief this outbreak has worked. A constant stream of patients was passing into and out of these institutions, while the infection was being distributed within them. Several discharged patients have already been discovered ill. In such subjects, weakened by previous disease, the results must be severe. The majority of the cases are of a bad type. Already there have died of the Western Infirmary group, 1 nurse and 3 patients; of the Belvidere group, 1 patient; of the Royal Infirmary group, 1 nurse and 3 patients.

Now, let us turn to the result of our investigation of the 40 sources of milk supply. All returned a clean bill of health save one. The following is the letter received from Mr. Kirkhope, South Fergushill, near Kilwinning:—

"South Fergushill, Kilwinning,
"6th September, 1884.

"Dear Sir,—In reply to your favour which I have just received this morning, I beg to make the following answers:—

"1st. One of my servant girls felt rather unwell on Tuesday morning last. Dr. Milroy saw her and gave her some medicine.

She felt no better on Wednesday, and we advised her to go home with her mother, who lives quite near. Dr. Milroy reports to us this morning that he is afraid of typhoid fever.

"Gastric and typhoid fever have been prevalent for some time in the villages of Fergushill and Bensley.

"2nd. There has been no sickness in my house (with that exception) since 1st June, but a great deal within 500 yards of my farm. The villages of Fergushill and Bensley are quite near, and belong to Messrs. A. Finnie & Son. More or less fever has been there for some months, and many adults have died.

"3rd. My cows have never suffered from any epidemic, but during the last seventeen years I have lost no fewer than thirty-nine dairy cows besides young cattle. Their illness and death I have attributed to the bad water supply on my farm. The sewage of Fergushill and Bensley run into the burns from which my cattle drink. For some years I could not understand what was the cause of so many deaths, for my father rented this same farm for between twenty and thirty years, and he never lost more than three cows during that time, although his stock was beginning to get sickly, and became worse on my hands; that, no doubt, was owing to the increase of the population of these villages.

"I have done everything I possibly could do within the last three years. I have called the attention of Mr. Glen, manager to the Messrs. Finnie. He merely laughed, and said it was a fancy I had got into my head about bad water, although the burns were then visibly in a state of stench.

"Since then I informed the Honourable G. R. Vernon, commissioner to my landlord, the Earl of Eglinton, and Mr. Stewart, Lord Eglinton's factor. Since I spoke to them a filter has been erected at each village through which the sewage flows; but I am told on good authority that the poison from the sewage runs from the filters with the liquid into the burns from which my cattle drink. Since the filters were erected I asked both the Sanitary Inspector and officer for the district to look at the state of the burns. They told me that I should not complain to them, seeing that I had told Mr. Vernon and Mr. Stewart about it. I also directed the attention of Mr. M'Gill, veterinary surgeon, Stewarton, who attended to two of my cows lately. His opinion was that they both suffered from the effects of drinking bad water.

"I have also had the water of one of the burns analysed, and have just had the report to-day, which is very bad. During the winter and early spring I had my cows watered from the well that supplies us for domestic purposes. They drank freely so long as we could give it to them, but the spring which supplies our well is injured by the workings of the Messrs. Finnie, the result being that we had to withdraw it from the cattle.

"I will be very glad if Dr. Russell, medical officer of health for Glasgow, will cause an inspection to be made, and I will discontinue sending milk until he is satisfied.—I am, yours very truly,

"JOHN KIRKHOPE."

The last milk was sent from this source on the morning of 6th September. On the 8th I inspected the locality. I found that a dairymaid, aged 16, whose parents live in the adjacent village of Fergushill, had a shivering on 23rd August; on the 31st she told her mother that she had a bad headache; on the 1st September her mistress noticed she looked ill; on the 2nd she was seen by Dr. Milroy, Kilwinning, who suspected fever; on the 3rd she ceased to work, and went home; on the 8th I saw her very ill with typical enteric fever. Her father had been ill with a slight attack of the same disease a fortnight before her. I verified all the statements of Mr. Kirkhope as to the water supply and general condition of the villages which drain into the burns which pass through his farm. The population of Fergushill is 537, of Bensley 318. There have been during the last two years over 100 cases of enteric fever in these villages. It is the usual fate of every new-comer to have this "fever of the place." From a return furnished by the local Registrar, I find that since 1st January, 1883, there have been 5 deaths from "gastric" or "enteric" fever. Of these 4 were in 1883, which gives a death-rate of 4·67 per 1,000, that of Glasgow for the same year being 0·3. As to the unhealthiness of the cattle, and its relation to impure water, I have the following letter from Mr. M'Gill, V.S., Stewarton:—

"Stewarton,
"September 11th, 1884.

"Dear Sir,

"I hereby certify that I visited and examined two Cattle at the farm of South Fergushill (Mr. Kirkhope's), on 26th June last. I found one cow suffering from diarrhœa and very much fevered. There was a very offensive smell from her breath, and the fœcal evacuations were perfectly black and very offensive. The other

cow was also fevered and suffering from severe irritation of the kidneys, the urine being scanty and offensive in smell. After examining the Cattle, and finding no probable cause for these diseases, I suspected that it must arise from some defect in the water supply, and went to the fields to examine it. The water was running in a scanty stream, and was very black and filthy looking, and in stagnant pools it was coated over with a black fluid of sewage. The sewage from the two rows of colliers' houses was entering directly into the stream at the corner of the field, and above these houses and the other farm the stream of water was quite clear. The two Cattle I attended recovered, so that I had no opportunity of making a post-mortem examination. I am firmly of opinion that the polluted water supply was the source of the disease, and that the water was perfectly unfit to be consumed by Cattle with safety.

"Yours truly,

(Signed) "WM. G. M'GILL, V.S.

"Dr. Russell,
"Sanitary Department,
'1 Montrose St., Glasgow."

In a letter dated 11th Sept., Mr. Kirkhope says—"I am sorry to say that four of our cows have been suffering severely since you were here, and we were obliged to send for our local Vet., Mr. Merry, Irvine, who distinctly says that the disease they are suffering from is caused by the impure water they are drinking." I saw the sewage oozing into the burn at Fergushill. There had been heavy rain on the night preceding my visit, and when the samples were taken from the two burns on the 9th, they were in flood after another heavy fall of rain. Dr. Clarke's analyses, therefore, give no idea of the state of things during dry weather, as to which there is a concurrence of local testimony. The aspect of the Fergushill well—a hole in the middle of the hollow square formed by the miners' cottages—was quite as repulsive as the analysis of the sample taken. The well which supplies the farm is sunk in the middle of the yard, and the analysis shows that it also is contaminated. As to the farm steading it is in bad repair, but in general very clean, and the farmer evidently does his best in the adverse circumstances imposed upon him. The following are the analyses referred to:—

ANALYSES.

Analysis of a sample of water from a spring pump well at South Fergushill Farm, Kilwinning, Ayrshire, marked No. 132, received on the 10th inst.

	Grains Per Gallon.
Carbonate of Lime,	3·64
Carbonate of Magnesia,	1·16
Sulphate of Lime,	5·68
Chloride of Calcium,	1·00
Chloride of Magnesium,	2·50
Chloride of Sodium,	4·41
Nitrate of Soda,	4·80
Phosphates, &c.,	·28
Silica,	·14
Organic and Volatile Matter,	6·77
	30·38
Free Ammonia,	·0016
Albuminoid Ammonia,	·0028
Nitric Acid,	2·57
Oxygen required for readily oxidisable Org. Matter,	·057

The results of my Analysis show that this Water is grossly contaminated with the products of sewage, and although these seem to be in an oxidised condition at present, such a large proportion of Nitric Acid indicates that the soil in the neighbourhood of the well is saturated with sewage matters, and the use of such a Water is, in my opinion, attended with great danger.

JOHN CLARK, Ph.D.,
City Analyst.

Analysis of a sample of water from public dip well in Fergushill Village, Kilwinning, Ayrshire, marked No. 133, received on the 10th inst.

	Grains Per Gallon.
Carbonate of Lime,	2·80
Carbonate of Magnesia,	1·28
Sulphate of Lime,	8·57
Sulphate of Magnesia,	·83
Chloride of Magnesium,	1·49
Carry forward,	14·97

	Grains Per Gallon.
Brought forward,	14·97
Chloride of Sodium,	5·13
Nitrate of Soda,	4·32
Phosphates, &c.,	·84
Silica,	·56
Organic and Volatile Matter,	4·32
	30·14
Free Ammonia,	·0098
Albuminoid Ammonia,	·0042
Nitric Acid,	2·310
Oxygen required for readily oxidisable org. matter,	·185

This Water is grossly contaminated with the products of sewage matter, and its composition is similar to what would be obtained by filtering a mixture of 1 part of Glasgow sewage and 4 parts of pure Water through a porous soil. In my opinion the use of this Water for dietetic purposes is attended with great danger.

JOHN CLARK, Ph.D.,
City Analyst.

Analysis of a sample of water from Fergushill Burn in Ward's Field, near the fallen tree, Kilwinning, Ayrshire, marked No. 134, received on the 10th inst.

	Grains Per Gallon.
Carbonate of Lime,	6·06
Carbonate of Magnesia,	Trace.
Sulphate of Lime,	1·52
Chloride of Magnesium,	·90
Chloride of Sodium,	1·33
Nitrate of Soda,	Trace.
Phosphates, &c.,	·28
Silica,	·42
Organic and Volatile Matter,	3·87
	14·38
Free Ammonia,	·010
Albuminoid Ammonia,	·014
Nitric Acid,	Trace.
Oxygen required for readily oxidisable org. matter,	·385

This water contains more organic impurity than is found in good drinking water, but there is not sufficient evidence that the impurity is derived from sewage matter; and, although I could not recommend the use of this water for household purposes, I am not prepared to say that it is unfit for cattle.

JOHN CLARK, Ph.D.,
City Analyst.

Analysis of a sample of water from Bensley Burn at a point after passing under the railway, near a large Saugh Tree, marked No. 135, received on the 10th inst.

	Grains Per Gallon.
Carbonate of Lime,	5·29
Carbonate of Magnesia,	·31
Sulphate of Lime,	·70
Sulphate of Magnesia,	1·66
Chloride of Magnesium,	·20
Chloride of Sodium,	2·18
Phosphates, &c,	·35
Silica,	·63
Organic and Volatile Matter,	4·28
	15·60
Free Ammonia,	·006
Albuminoid Ammonia,	·015
Nitric Acid,	None.
Oxygen required for readily oxidisable org. matter,	·857

This Water is too impure in my opinion to be used for dietetic purposes, but, as the impurity seems to be of vegetable origin, I am not prepared to say that it is unfit for cattle.

JOHN CLARK, Ph.D.,
City Analyst.

There are 20 milk cows at South Fergushill Farm. The following is a statement of the milk sent into Glasgow during the month of August, and the amount supplied by the agent to the three institutions :—

	Despatched from Fergushill.	Western Infirmary.	Belvidere.	Royal Infirmary.
Sweet milk (gallons),	908	1,607	2,292	1,551
Skim do. do., ...	—	1,011	416	761
Cream (gills), ...	—	186	62	480

Though the milk sent from Fergushill is accounted for and charged as sweet, it was all despatched as skim and cream. It

left Montgreenan Station every morning at 7.51, reaching St. Enoch's at 9 a.m. The morning milking was, therefore, kept 24 hours on the premises, the evening 12 hours. The Saturday morning milking was despatched on Saturday evening. Therefore the Monday morning's despatch comprised milk which was 36, 24, and 12 hours old. These facts are of importance, as I believe milk skimmed by the farmer is the most dangerous, if there is danger. It is longest exposed to local influences, and the specific germ multiplies, and so intensifies the specific energy before it reaches the consumer. Milk is delivered at all the hospitals morning and evening in about equal quantities of each sort on each occasion. The average afternoon supply would therefore be :—

	Western Infirmary.	Belvidere.	Royal Infirmary.
Sweet (gallons), ...	26	38	26
Skim, do., ...	17	7	13

It is obvious, therefore, that while the proportionate amount of the Fergushill supply was small, it was amply sufficient on any one day to yield the whole or the larger part of this delivery at each institution, in the chances of the daily distribution, being 25 to 30 gallons on the daily average, and on Mondays 40 to 45 gallons. But after milk has been traced from any source into the agent's hands, it is useless to speculate as to the mode of its distribution, and the chances of its turning up here or there in the various channels by which it leaves him. Of course it is not probable that the hospitals absorbed this particular milk invariably. Indeed, though I am not yet in a position to give details, I have evidence that it has produced disease among other consumers of milk from the same agency. The agent admits that it may have reached these Institutions at times.

I find from personal enquiry that the condition of this district of the rural parish of Kilwinning is a matter of public notoriety. The villagers, the doctors, the farmers, everybody is alive to it. I was shown letters in the *Irvine Herald* about it. The Local Authority and the landlord alone are indifferent to it. There could be no more glaring proof of the hollow farce of rural sanitary administration in Scotland than we obtain by looking from this state of things in the parish of Kilwinning back upon the circulars issued by the Board of Supervision specifically upon the sanitary inspection of dairy farms, beginning with 25th Nov., 1875, and ending no further gone than 27th August, 1884. That circular was addressed to the Clerk of the Local Authority of Kilwinning, as of every authority in Scotland, and informed him as follows:—"The provisions of article V. of the Directions and Regulations "issued on the 28th July, 1884, shall extend to and include water "used in Cow-houses, Dairies, and Milkshops, either by Milch Cows "or for the purpose of washing and cleansing vessels intended to "contain milk, or for any other purpose connected therewith." Said Article V. enjoins with all the authority of an Order in Council in anticipation of Cholera, and for the second time in two years—

"V. In any case in which there is any doubt as to the whole- "someness of Water used by the inhabitants as a beverage, or for "dietetic purposes, the Local Authority shall take immediate "steps to ascertain the quality of such Water, and if it shall be "certified after analysis by a competent Analytical Chemist or "by a qualified Medical Practitioner that the Water of any "Well or other source used as a beverage or for dietetic purposes "within the jurisdiction of the Local Authority is so tainted "with impurities, or otherwise unwholesome, as to be injurious "to the health of the persons so using it, or calculated to promote "or aggravate choleraic or other epidemic, endemic, or contagious "disease, the Local Authority are hereby required to take prompt "measures for procuring wholesome Water to be supplied in its "stead, so far as the case requires, to the inmates of the houses "situated within the limits of their jurisdiction, and to prevent "the use as a beverage or for dietetic purposes of the unwhole- "some Water, by shutting up any Well or Wells from which it "is drawn, or otherwise as the circumstances may require. If "the Medical Officer shall have reason to believe that any Water "used as above stated is unwholesome, the Local Authority shall "at once prevent its use until it has been analysed."

The Local Authority put the Circular in their waste basket, and it has been left for you, in self-defence, to obtain these analyses. It now remains for you to forward the results to the Board of Supervision in the hope that some means may by it be found to compel the Local Authority to do their duty. It is by such by-paths that Cholera will find its way into our large cities.

JAS. B. RUSSELL.

Sanitary Department,
1 Montrose Street,
18th Sept., 1884.

Medical Staff Library
from E.A. Parkes.

REPORT
ON AN
OUTBREAK OF ENTERIC FEVER
CONNECTED WITH MILK-SUPPLY.

BY

JAMES B. RUSSELL, M.D.
MEDICAL OFFICER FOR THE CITY OF GLASGOW.

REPRINTED FROM "THE GLASGOW MEDICAL JOURNAL," AUGUST, 1873.

I HAVE received so many applications for copies of this Report, and it is so evidently necessary to preserve for future use all the facts concerning those outbreaks of enteric fever connected with milk-supply, that, even at this late date, I venture to publish it in this Journal. To Glasgow readers the story must be stale; but, as it appeared nowhere in full but in the Glasgow newspapers, to others the facts cannot be so familiar. The relation of Zymotic disease to milk is one of the most important questions in etiology of the present day; and Dr Dougall's paper, in last number of this Journal, is the first attempt to explain on general principles the action of milk as a distributing medium. The report is given here exactly as originally presented, with the addition of a foot-note here and there. J. B. R.

Report concerning a Remarkable Local Prevalence of Enteric Fever in Parkhead, Glasgow, in January, 1873.

In my fortnightly report, dated 1st February, 1873, I stated that "a remarkable local prevalence of enteric fever in the Eastern District is at present under my observation, and may probably furnish us with some interesting facts for a future report."

The suburb of Parkhead, to the extreme east of the city boundary, retains the features of a country village, and neither in the character of its inhabitants nor of its buildings is it suggestive of the city. That portion of it to which this report specially refers lies to the south of the Great Eastern Road, comprising Dalmarnock Street, Burgher Street, M'Ewan Street, and Helenvale Street. These streets run out to the open fields, and are made up of cottages and tenements not more than two stories high, tenanted by weavers or their descendants,—comfortable, cleanly, well-living people.

There are no water closets in their houses: the combined ash-pit and privy are universal. The drainage is mostly surface, leading to the fields; at anyrate, there is no communication with a sewer system. The water supply is abundant, from Loch Katrine.

The occurrence of contagious fever of any kind in an epidemic form in the district described has never been observed by the department. During the entire year 1872, only five cases of fever were known to have occurred in the streets named. It was, therefore, somewhat startling to find about the middle of January many families suddenly attacked with enteric fever, and to discover, on house to house visitation, evidences of a severe and distinctly localised outbreak of that fever, limited in duration to that month, and especially to the fortnight between the 8th and 21st.

The facts were suggestive of some common cause acting for a limited time on this limited area. The discovery of this cause was, of course, very desirable. I shall not trouble you with a history of the inquiry, which has been tedious, but merely state the result.

In the first place, I believe we have got a perfectly complete list of every case of fever in Parkhead and Westmuir since 1st November, 1872, made up by inquiry at every house in the district. I have seen a large proportion of the cases and inspected the houses myself. In November there were 8 cases—4 of typhus and 4 of enteric fever. In December there were 3 cases *at least* of enteric fever in two families, one of these was the family of a dairyman, and I say at least three

cases, because, while one child in the family of this dairyman is admitted to have had "*gastric*" fever, it is almost certain that more than one had the disease, though in a mild form. This was the state of matters up to the end of 1872. In January, 1873, enteric fever broke out in 39 families, in which it attacked 53 individuals. In February we know of only two new cases, and those in families previously attacked. The explosive nature of this epidemic is evident from these figures.

In the course of my inquiry, I found that not only had enteric fever been in the family of this dairyman in December, but among those attacked in January were a daughter-in-law who lived next door, and her sister who lived at the other end of the same street. Following this clue, I found that every family in this street where the fever was got milk from the same dairyman. There were 10 families ill of enteric fever, and without exception they were customers of his.

Further, having ascertained the milk supply of all the families attacked in January, I found of the total 39 that 32 were supplied by the dairyman, and yielded 46 cases of fever, while only 7 families were supplied elsewhere, and these yielded only 7 cases.

It certainly was a remarkable fact, and one hardly to be explained away as a mere accident, that having ascertained all the cases of fever without exception in a district, we should find that while one dairyman, whom we shall call X., was associated with 46 cases, the name of only one other dairyman was mentioned twice, and that the remaining five cases were supplied from five distinct sources.

It might, however, be that X. supplied such a proportion of the inhabitants as compared with other dairymen, that if fever broke out in the district at all, it was certain to seize his customers in much greater numbers.

On obtaining a list of the dairymen and milk-sellers in the whole of Parkhead and Westmuir, it was evident that the chances were very much in favour of other dairymen appearing in the position of Mr X. There were 12 sources of milk supply, and taking only those where cows were kept and no other milk sold, I found that while Mr X. sold the milk of 10 cows, his neighbouring dairymen, 8 in number, sold the milk of 64 cows. It is scarcely conceivable that any mere chance could bring Mr X. into such prominent relationship with enteric fever.

A still more exact test of the relation between Mr X. and the distribution of enteric fever was to find the source from which every family in the district obtained their milk, and so ascertain the proportion of each dairyman's customers attacked with fever. It seemed to me equally sound as a test, and not so laborious, to take the streets where the majority of the cases occurred, and ascertain how many customers each dairyman had in those streets. Burgher Street, Dalmarnock Street, Gray's Lane, M'Ewan Street, and Ravel Row, contained 24 out of the 39 families, and were dissociated in space and yet so short as to be subjected throughout to the action of similar local circumstances, so that every one residing therein would have an equal chance of being caught by an epidemic cause of local origin. The following is the result:—

In Burgher Street 28 families were supplied by Mr X., and out of these 10 were seized with enteric fever in January, and four had suspicious cases of sickness, while 43 families were supplied by other persons and not one of them had fever or a single suspicious case of disease.

In Dalmarnock Street 28 families were supplied by Mr X., and four of these had cases of fever, while 20 were supplied elsewhere, and only one of them had fever.

In Gray's Lane six families were supplied by Mr X., and four had cases of fever, while 20 were supplied elsewhere, and only one of them had fever.

In M'Ewan Street nine families were supplied by Mr X., and two had cases of fever, while nine were supplied elsewhere and had no fever.

In Ravel Row there are just 11 families, of whom only two were supplied by Mr X., and these were the only two families who had fever.

The summation of this milk-census is this, that in five streets where the milk supply of every family was ascer-

tained, out of 73 families supplied by Mr X., 22 had fever, and out of 146 supplied elsewhere only two had fever.

Having thus stated the chief points in proof of the case against Mr X., one or two striking corroborative features of this outbreak may be remarked.

1st. Enteric fever in families supplied by Mr X. frequently attacked several members of the family, so that 32 families yielded 46 cases. In families supplied otherwise it occurred only in isolated cases as we usually see enteric fever in Glasgow.

2nd. The fever was much more fatal in the families supplied by Mr X. Out of these 46 cases there were 6 deaths, while there were no deaths in families supplied elsewhere.

3rd. In two families supplied by Mr X. we were told that the two individuals seized were the only members of the family who used that milk. In both cases it was used with porridge, while the others took sour-milk in one instance and syrup in the other.

4th. The families in Great Eastern Road, Chapel Terrace, and New Road, having cases of fever and supplied by Mr X. where no milk census was taken, are scattered about quite capriciously over a considerable area, and yet they number 10 against 5 supplied elsewhere.

5th. We ascertained the date of sickness in all these cases, and of the 46 supplied by Mr X. 6 sickened in the first week of January, 17 in the second week, 14 in the third week, 9 in the fourth week, while of the 7 cases supplied elsewhere there is no such clustering together.

The period of incubation of enteric fever, *i.e.*, the interval which may elapse between the introduction of the poison into the system and its activity, may extend to three weeks. This carries us back to the end of December, when Mr X.'s family had enteric fever, when the germs of the disease on one or more occasions got into his milk, and were distributed to those unfortunate persons who were, one by one, attacked during the month of January.*

* I have been asked how the germs of the disease got into the milk. The only additional fact which I can give is that the person who habitually milked the cows was the person who nursed the children. As stated already, Loch Katrine water alone is used, drawn from a tap in yard.

I regard this as an extreme illustration of what must frequently happen where the sale of articles of food is conducted in close connection with families with all their attendant ailments. Milk is, from its composition, a peculiarly favourable medium for the propagation of the germs of disease, and particularly of enteric fever. It is seldom that this fever is diffused by milk in circumstances which permit us to trace the disease home to the milk so clearly as in the Parkhead case; and it is very likely that many apparently inexplicable outbreaks of enteric fever in families are caused by milk, or even solid food, contaminated in the retail shops, especially among the poor.* It is a very common practice in all parts of the city for parties to live and rear families in rooms behind shops, through which often the sole access lies, and in which groceries, milk, provisions of all kinds, sweetmeats, fruit, &c., &c., are sold. These shops are "served" by one or both parents, or some grown-up child, and when infectious disease enters such a family it cannot fail to be the source of quite peculiar risk to the public. I have been so much impressed with this by a series of cases in point that I submitted the following three illustrations to Mr Lang, Procurator Fiscal, to ascertain what legal powers existed to deal with them:—

1st. "Provision shop served by mother of family, consisting of eight individuals living in back room, a lodger slept on a shake-down *in the shop.* Two of the children had enteric fever in the beginning of January, and the death of one of them drew our attention to the case. I put the alternative to the parties, either to shut the shop or to allow me to remove the family to the Reception House and Hospital, and after much hesitation the latter course was adopted."

2nd. "Shop for sale of groceries, including bread, butter, ham, 'potted head,' &c., similar construction to previous case, only back room much smaller and no back-door, occupied by man and wife and three children. The man had been ill of enteric fever for 25 days before we discovered the case.

* I have a strong suspicion that an outbreak of enteric fever in Drygate, last autumn, was promoted by milk-supply; at anyrate, it prevailed chiefly among the customers of a dairyman who had that fever in his own family.

During all that time the excreta must have been carried through the shop in order to reach the midden by the close, and the shop was 'served' by the man's only nurse and attendant—his wife. I put the same alternative before this woman, instantly to shut the shop or to send her husband to hospital, and she adopted the former course."

3rd. "I am aware of a baker's shop doing a flourishing business, the proprietors live in a house of four apartments in direct communication with the shop. Two members of this family had small-pox, one dying after an illness of 15 days."

Mr Lang writes his opinion "that persons situated as described in the various instances given in your letter, have not 'proper lodging or accommodation.'" It will therefore be possible by this and other provisions of the "Public Health Act," to deal with such cases so as to save the poorer classes from the obvious dangers of contagious sickness in such circumstances.* I have therefore issued, through Mr Macleod, to the Sanitary Inspectors an instruction "that systematic attention be paid to the health of all families living in the circumstances described, by a more routine visitation than from the character of the people and the locality might be thought necessary. Any case of infectious disease discovered must be specially and immediately reported to the medical officer. He wishes the greatest care to be taken not to injure the interests of the parties referred to by unnecessary publicity in the discharge of this duty; but at the same time there is a very obvious danger to the public from their private sickness, arising from their mode of living, which quite warrants the interference of the department."

(Signed) JAS. B. RUSSELL.

3rd March, 1873.

* I am informed by the Board of Supervision, in acknowledging receipt of the above Report, that "They are of opinion that under Section 42 of the 'Public Health Act' the Local Authority are entitled to take action in such cases." Considerable misunderstanding exists as to the powers conferred by this Section, but it is evident that if the words "proper lodging or accommodation" embrace a consideration in the fullest sense of what is "proper" in relation to public safety, then the Local Authority have the most ample power to remove under warrant any person suffering from infectious disease, and situated in relation to the public as the family of a dairyman are.

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ON SOME POINTS OF INTEREST

CONNECTED WITH THE WANKLYN METHOD OF

SANITARY WATER ANALYSIS

PARTICULARLY ON THE DETECTION OF

RECENT SEWAGE

AND THE DETERMINATION OF THE

NATURE OF THE ORGANIC MATTER.

BY CHARLES SMART,
Major and Surgeon U. S. Army.

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NOT a great many years ago sanitary chemists affected a more precise knowledge of the organic matter in a water than those of the present day attempt to claim. Results were announced in grains per gallon; and the outside world conceived that the whole matter was understood. More recently the establishment of arbitrary scales of purity or impurity, based on the results of special processes, has taken the place of the former method of giving a verdict, and the outside world, when not trammelled by personal considerations, has acquiesced in this assumption of special knowledge. Occasionally, as a consequence of this, an analyst at the present time falls in the esteem of certain individuals when he acknowledges his inability to give full information concerning the organic matter in a water, to state positively whether a water is wholesome or unwholesome, or to detect a trace of sewage which is known, or strongly suspected, to be present. Even men well versed in the general principles of sanitary science, have, by these acknowledgments, been led to regard the laboratory work of the analyst as a kind of quasi-scientific hocus-pocus, which tells as little as the ancient oracle. The fact is that although the principles involved in these processes are incapable of indicating whether a specific morbific agency is present, they very frequently throw much light on the probable character of a water. Microscopical and biological inquiry will perhaps ultimately supercede the purely chemical methods; but the former are in their infancy as yet, and although very promising as children, it remains to be seen whether they will fulfill their promise. Meanwhile the work of the world in this line has to be performed by the chemical processes and it is encouraging to know that the more these are studied the more definite becomes the testimony they are capable of yielding.

I propose here to refer in particular to certain results of the Wanklyn process that are not generally appreciated. This process measures the free ammonia in a water and afterwards the albuminoid ammonia, or that formed by the breaking up of the nitrogenous organic matters. The former, when in relatively large quantity, and particularly in well waters, is usually due to cesspool, sewer, or privy connections. The latter is a measure of the existing impurity, and, if relatively large, is naturally suggestive of unwholesomeness. Wanklyn's arbitrary limits of wholesomeness are well known and need not be repeated.

It is generally understood or assumed that the results given by the same water are always identical. On the contrary they may be modified by the manner in which the process is conducted.

IMPERFECT CONDENSATION

of the evolved ammonia causes a loss which may vary from 1 to 12 per cent. of the total, according to the slowness or rapidity of the distillation and the temperature of the current in the condenser. Slow distillation and a condensing current at winter temperatures give the minimum of loss; rapid distillation and a condensing current at summer temperatures, the maximum. This affects the total of both the free and the albuminoid ammonias; but the latter is affected even to a greater extent by the time occupied in the distillation, or by the

IMPERFECT CONCLUSION OF THE EXPERIMENT.

Wanklyn has acknowledged that his process is imperfect and that the whole of the nitrogen of the organic matter is not converted into ammonia; but he claims that, as the albuminoids in a water are of similar constitution, and yield up a definite percentage of their nitrogen, the results of the process in different instances are susceptible of comparison, and enable the operator to rate the water on an arbitrary scale. This claim is not wholly sustained by the results of recent investigations. The albuminoid ammonia does not pre-exist in the water; it is formed during the analytical operation, and requires time for its formation. The element of time is an important one. The nitrogen of some organic matters is slowly converted by boiling with the alkaline permanganate—so slowly that the experiment may reach its conclusion, by the disappearance of the water from the retort, before the whole of the nitrogen has been liberated as ammonia. This occurs with most of the alkaloidal substances. If an organic matter require boiling for two hours with alkaline permanganate to reduce and liberate its nitrogen a rapid progress of the experiment concluding the distillation in one hour will yield only a percentage of the nitrogen. A weak flame will give higher issues of albuminoid ammonia from the same organic matter than a strong flame, because it prolongs the action on the one hand, and lessens the loss from imperfect condensation on the other. In all instances in which the organic matter is slowly decomposed, the yield of albuminoid ammonia will vary with the time occupied by the distillation. Some waters will give very different results, according as the process is conducted at a rate of ten or of twenty minutes for each measure of 50 cubic centimeters distilled. It is needful to bear these irregularities and imperfections in mind, for some of them give important indications as to the source and quality of the organic matter.

DETECTION OF RECENT SEWAGE.

This may be effected by noting the peculiar behavior of urea when submitted to the Wanklyn process. A few nitrogenous substances are not decomposed by the action of the alkaline permanganate solution; among these Prof. Wanklyn includes urea. He is very positive on this point. He says: "Except in the instance of nitro-compounds, urea and ferrocyanide of potassium, we have not met with any unequivocal instance of failure of an organic nitrogenous compound to evolve ammonia in being heated to 100° C, with a strongly alkaline solution of permanganate." And again: "In presence of permanganate and excess of potash, urea is doubtless decomposed; but it yields no ammonia, which is a very extraordinary and noteworthy fact." And further: "On inquiring into the other peculiarities of structure which prevent alkaline permanganate evolving nitrogen of a given organic compound in the form of ammonia our attention is arrested by the example of urea which evolves none of its nitrogen as ammonia when so treated."

Nevertheless, urea yields about 22 per cent. of its nitrogen as ammonia when treated as Wanklyn treated the alkaloids and other organic substances in determining the amount of their nitrogen evolved as ammonia by permanganate; and if the conditions of the experiment be arranged to permit of a longer continuance of the action of the permanganate on the urea, the whole of its nitrogen will be accounted for, provided that due allowance be made for loss from imperfect condensation.

Urea in solution is resolved gradually into ammonia. This is hastened by boiling, and hastened yet more by boiling with alkaline permanganate. If a solution containing 1 mgrm. of urea in 500 c. c. of ammonia-free water be distilled, the first measure of 50 c. c. which comes over will contain a comparatively large quantity of ammonia, because during the time occupied by the liquid in reaching the point of ebulition a certain portion of the urea has been decomposed. The second measure will contain less, and the third, fourth and subsequent measures will each contain .01 mgrm. of ammonia, showing that boiling for the time ordinarily occupied in the distillation of 50 c. c. liberates the nitrogen necessary to form that amount of ammonia. Again, if a solution containing 1 mgrm. of urea and a charge of alkaline permanganate in 500 c. c. of ammonia-free water be distilled, the first measure of 50 c. c. which comes over will contain a relatively large quantity of ammonia. The second will contain less, and the third, fourth and succeeding measures will each contain .02 mgrm. of ammonia, showing that the presence of the alkaline permanganate has as strong an influence in effecting the decomposition of urea as is exercised by the boiling temperature. After all pre-formed ammonia has been liberated from an ureal solution an equable and persisting evolution takes place which may be represented by N in the absence of caustic alkali and permanganate, and by twice N in the presence of these reagents.

Dilutions of fresh or decomposing urine in tap water give similar results. When these are treated as water samples by the Wanklyn process there is first a liberation of the pre-formed ammonia, and afterwards an equable decomposition of the urea by the continued boiling. Then on the addition of the alkaline permanganate there is a comparatively free liberation of ammonia from the urea and other nitrogenous substances that may be present and afterward a persisting and equable evolution, each measure of 50 c. c. containing as much again as the corresponding measure distilled in the absence of the permanganate. This peculiarity in the behavior of urea is of importance, as by it the presence of this substance may be recognized in a water. It does not appear that any other substance gives issue to the free and the albuminoid ammonias in the manner stated. Many organic chemicals have been examined and also many organic substances, including the waste products of manufactures, etc., but not one was found to present reactions by which it could be comfounded with urea. Many gave a persisting and equable evolution of albuminoid ammonia, but few of these gave at the same time a persisting evolution of free ammonia; and where in some exceptional instances of factory drainings there was a persisting evolution of both free and albuminoid ammonia, these ammonias were not yielded in the proportion of 1:2.

Moreover the observations on the decomposition of urea have an approximatively quantitative value;—for since 1 mgrm. of urea in 500 c. c. of water gives a persisting and equable evolution of .01 mgrm. of ammonia when distilled alone or with sodium carbonate, as in the first half of the Wanklyn process, and an evolution of .02 in each measure when subsequently treated with the alkaline permanganate, a water sample which yields such results must have contained urine equivalent to, at least, 1 mgrm. of urea. Thus, a water which yielded in successive distillates of 50 c. c., each .47, .25, .15 and .15 mgrm. of free ammonia, and afterward .54, .34, .32 and .32 mgrm. of albuminoid ammonia, respectively in each of four measures distilled from alkaline permanganate, might be set down as having contained urine equivalent to, at least, 15 mgrms. of urea in the 500 c. c. of water used in the experiment. The urea in urine is, of course, a variable quantity, but as the mean of a number of experiments on fresh urine, it was found that one half of a cubic centimeter in 500 c. c. of distilled water, or 1 part in 1000, yielded the returns given above as indicating the presence of 15 mgrm. of urea in the 500 c. c. treated by the Wanklyn operation. From these data the quantity of urine present in a given sample of polluted water may be approximately estimated.

The writer was so impressed with the importance and reliability of these observations on the persisting evolution of free and albuminoid ammonia from urea that on one occasion when an unknown water, sent to him for examination, yielded such results, he did not hesitate to report the water as polluted by so much urine per gallon. His purpose was to make this a test case; and he succeeded, although he was not informed of the fact until nearly two months afterward, when, having reported another unknown water as a rain water, shed from a clean roof and stored in a sound and clean cistern, he was made acquainted with the following particulars:—

Typhoid fever appeared in a cottage built by a gentleman as a summer residence. The quality of the water was suspected, and a sample analyzed by Prof. E. S. Wood was pronounced unfit for use. A second chemist having confirmed this verdict, a physician inspected the premises and suggested that sewer gases from the ventilating pipe of the water closets might have been condensed on the roof and washed thence into the cistern. Measures were taken to remedy this assumed evil, and the cistern was pumped out, cleaned and relined with cement. The water sample which was condemned as containing so much urine per gallon, was taken from this cistern after it had thus been subjected to careful and scientific treatment. Naturally, the proprietor was shocked; and, in view of his efforts to procure a fair rain water, felt disposed to question the analytical results rather than the quality of the water. Fortunately, however, Mr. E. W. Bowditch, of Boston, who was conducting the sanitary survey of the premises, conceived that further investigation was imperatively required. Ultimately in his examination he discovered that there were three apertures in the cistern, although only two conductors from the roof entered it. On inquiry it was remembered that a few years before, in making some additions to the cottage, a conductor had been disused, but what had been done with it was not known. The track of this old conductor was then uncovered at its cistern end, and followed to its termination in an open mouth a foot below the surface near the porch of the building. A luxuriant growth of vines rose from the surface at this point, and these vines were from time to time nourished with chamber slops. It was moreover found to be the custom of the house to collect all such slops in pails which were emptied through a water closet on the first floor and then set out on the roof of the piazza to air. The old conductor was removed and its cistern aperture sealed, and the connection was cut between the cistern and the roof of the piazza. When the water again accumu-

lated after these changes had been effected, the sample submitted for analysis was reported as a satisfactory rain water. This appears to illustrate the value attaching to the manner in which the ammonias come over during the distillations of the Wanklyn process, and it is specially mentioned here on account of the difficulty encountered in verifying the accuracy of the chemical results. Many other illustrations might be given, but they are unnecessary.

ANIMAL OR VEGETABLE MATTER.

Wanklyn has observed that when a water containing vegetable matter is distilled with the alkaline permanganate solution the albuminoid ammonia comes over very slowly. In verifying the accuracy of this statement, it was found that the rapidity of the evolution was determined by the instability of the matter, or its tendency to a state of putrescence rather than by its derivation. Pure animal and pure vegetable albuminoids gave up their nitrogen as ammonia at an equal pace when equal times were occupied in the distillation of the various measures. Thus, if the first measure of the distillate contained .24 mgrm., the second would contain .12, the third .06, the fourth .03, etc. But if these matters were in a decomposing condition, the second, third, and subsequent measures would each contain only one-third of the ammonia found in the measure that immediately preceded it. Animal matters, however, more readily pass into the putrefactive condition, so that when the organic matter of a water gives up its nitrogen after the manner first stated, there is a strong probability of its derivation from the vegetable kingdom; and this probability is rendered almost a certainty if a comparatively large quantity of oxygen is required for its oxidation when treated by the Kubel or Tidy method.

But vegetable matter in a state of fermentative change reveals itself during the Wanklyn process in two ways, neither of which appears to have been appreciated by any of the many analysts who make use of this method of sanitary analysis. The color produced by the Nessler reagent in a weak ammoniacal solution varies from a pale straw color to a dark sherry brown; but occasionally in testing the distillates of the Wanklyn process, particularly those containing the free ammonia, a green coloration masks the brown of the ammonia and prevents the accurate estimation of the volatile alkali. If there be but a trace of ammonia present, the color may be an olive-green, or even a citron-green, with generally a tendency to the development of a haziness in the liquid. No explanation of this color-interference has been furnished, although some years ago a reference was made to it at a meeting of the English Society of Public Analysts. Wanklyn does not even mention its occurrence.

The frequency with which this color-interference was encountered in certain experiments on water washings of air drawn over fermenting vegetable refuse, led me to conceive that it was due to an ethylic compound formed during the fermentation. A reference to my laboratory note books speedily showed that the green color was always associated with waters known to contain decomposing vegetable matter. In one instance the bilge-water of a sugar ship from Cardenas, Cuba, had given such an evolution of this coloring agent that Wanklyn's process was wholly inapplicable as an analytical method on account of the impossibility of effecting color comparisons. Experiments with ethylic ether and alcohol, with cane sugar, starch, glucose, tannin, and fermenting vegetable matter always developed the greenish coloration and haziness. Moreover, it was noticed that watery dilutions of these substances invariably struck a deep yellow color with sodium carbonate; and another reference to former laboratory work disclosed the fact that in all cases characterized by the green coloration of the Nesslerized distillate, the water had developed a yellow color on the addition of sodium carbonate for the liberation of the free ammonia. The yellow color thus assumed and the green coloration subsequently interfering with the Nessler reaction were therefore regarded as indicating the presence of non-nitrogenous vegetable substances in the progress of fermentative change. Hence, to summarize:

A water yielding up the nitrogen of its organic constituents slowly as albuminoid ammonia contains *recent organic matter*,—

Of *animal* derivation, if a small quantity of oxygen be required to oxidize it by the Kubel or Tidy process,—

Of *vegetable* derivation, if a large quantity of oxygen be required.

A water yielding up the nitrogen of its organic constituents more rapidly contains *decomposing organic matter*,—

Of *animal* derivation, if a small quantity of oxygen be required to oxidize it, and if there be no interference with the development of the true ammonia coloration during Nesslerization,—

Of *vegetable* derivation, if a large quantity of oxygen be required, and if a yellow coloration be developed in the water on the addition of sodium carbonate and a greenish color interfere with the estimation, particularly of the free ammonia, by Nessler's method.

PAMPHLETS

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