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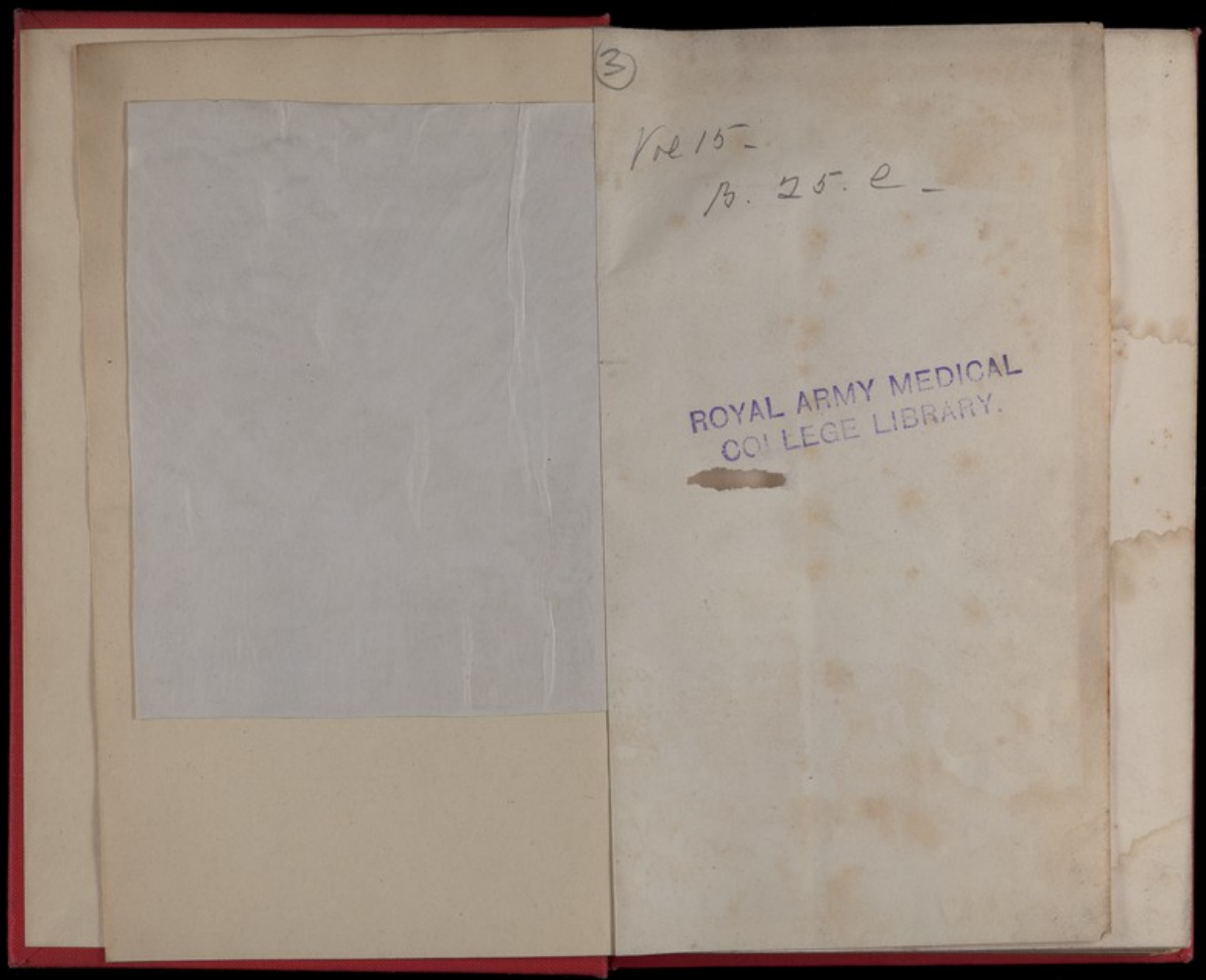

ON THE

CONCRETIONS OF THE TONSILS.

SHOWING

THEIR PARASITIC ORIGIN AND THE NATURE OF THE GRANULAR MATTER IN THE LEPTOTHRIX BUCCALIS.

BY

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ON THE

CONCRETIONS OF THE TONSILS.

WITHIN the recesses of the tonsils there occasionally form yellowish-white cheesy bodies, of tolerable consistence and very fetid odour. Mixed with the *sputa*, these concretions were long mistaken for tubercles. Laennec, at last, denied their pulmonary origin; and Höfle, discovering in them scaly epithelium, confirmed the suggestion that they form within the tonsils. He showed, moreover, that they are not tuberculous, and gave the following description of their microscopic structure:* "They are constituted for the most part of epithelium, pus corpuscles (?), oil-drops, and solid amorphous fat."

Rokitansky contributed little to what was already known upon this subject. He observes† that "In scrofulous subjects the tonsils are often affected, in addition to hypertrophy and habitual hyperæmia, with a peculiar blennorrhœa, and the purulent secretion not unfrequently becomes inspissated, so as to

* Wedl's *Pathological Histology*, Syd. Soc.
† Rokitansky's *Pathological Anatomy*, vol. ii. Syd. Soc.

form tubercular cheesy plugs, or even chalky concretions. These, in their turn, keep up a perpetual state of irritation in the tonsils." From the opinion here expressed respecting the origin of these bodies, I feel compelled to differ, inasmuch as I find, in addition to some epithelium and fat, a much larger quantity of—

1st. Granular matter.
2ndly. Filaments of two kinds.
3rdly. Vibrios.

Now, of what do the granular matter and filaments consist? Essentially of a parasitic fungus called Leptothrix buccalis.

I am bound to state that the presence of this fungus in the concretions of the tonsils has been before observed. Thus, Kölliker says:* "The greyish, yellowish, or greenish—sometimes softer, sometimes more consistent—material which is so frequently met with in the cavities of the tonsils as a somewhat abnormal occurrence, contains larger and smaller cells, with single nuclei, which have in part undergone the fatty degeneration, and which sometimes present hollow spaces in their interior and thickenings of their membranes; further epithelium and *occasionally* crystals of cholesterin and filiform fungi." We are also informed† that "Wedl found them (filaments of Leptothrix buccalis) in the molecular masses which collect between the tonsils in a dead body."

How is it, then, that the Leptothrix buccalis being

* Kölliker's *Manual of Human Histology.*
† Küchenmeister's *Parasites of the Human Body.* Syd. Soc.

already known, its presence in these concretions shall have been either entirely overlooked or described as only occasional and rare? Most probably because an erroneous opinion has hitherto prevailed respecting the nature of the granular matter and its relation to the filaments of the Leptothrix buccalis.

For the discussion of this matter it will be necessary to enter somewhat fully into the history of the fungus.

It was discovered by Leeuwenhoek* in 1722. Buehlmann† and Gerber next described it; but Henle‡ was the first who suspected its vegetable nature. Ch. Robin§ then gave a long and, for the most part, accurate description, which later writers have generally copied. He also named it Leptothrix buccalis.

According to this observer, it consists of fine transparent filaments, neither branched nor jointed, ·0005 mm. broad, and varying in length from ·020 to ·100 mm. These fibres are colourless and elastic, sometimes straight, but often bent, and always of the same diameter throughout. They may grow singly or in bundles; and whilst one extremity is free, the other is implanted in a granular amorphous mass, which is less a part of the fungus than the soil from which the latter grows. The borders of the filaments are well defined, and the filaments themselves look

* *Arcana Naturæ Detecta.* Lugd. Bat.
† *Arch. für Anat. und Physiol.* von J. Müller. 1840.
‡ *Anatomie Générale, traduction Française,* par Jourdan.
§ *Histoire Naturelle des Végétaux Parasites.*

homogeneous unless highly magnified (800), when small round bodies may be detected in their interior; which, however, to use Robin's words, are "très difficiles à bien étudier." In reference to spores, Robin remarks: "*Although in the whole genus Leptothrix spores are absent or unknown, there is reason to believe they would be recognised by a sufficiently powerful microscope. This supposition is founded on the fact that, in examining filaments of the Leptothrix buccalis under a magnifying power of* 800 *diameters, one sees, in the cavity of the tubes, little round bodies, possibly spores, developing in the interior, and escaping afterwards by the mechanism described further on in connection with Botrytis Bassiana.*" "*The granular amorphous mass upon which the filaments are fixed appears to be formed,*" says the same author, "*of azotised organic matter, consisting either of decomposing particles of food, kept together by their normal viscidity or by the saliva, or of the débris of epithelial cells, or of dried and decomposing mucus.*"

Kölliker, writing in 1860, evidently entertained the same opinion as Robin respecting the nature of this granular matter, for he says:* "The epithelial processes of the filiform papillæ are beset with fungi (Lep. buc.) Every microscopist is probably acquainted with brownish elongated (0·12‴ to 0·24‴ long, 0·04‴ to 0·08‴ broad) bodies, occurring on the coat of the tongue, and which consist of a dark axis and of a finely granular cortex. It is only the central

* Kölliker's *Manual of Human Histology.*

part of this structure which is composed of cornified epithelial plates, which come from the epithelial processes of the filiform papillæ; the granular cortex, on the other hand, is nothing else than the matrix of a filiform fungus with filaments of only 0·0006‴ in breadth, which *take root in it* often in enormous quantities."

In Küchenmeister's book there is a passage bearing on this subject: "Under the highest powers of the microscope, small round granules (spores) can be seen in the space between the filaments." But the value of this is negatived by the counter-observation, "nor are there sporangia or clearly spores present." In fact, I think it probable that the author meant *within*, rather than *between*, the filaments; for his opinion of the granular matter is expressed too plainly to admit of any doubt as to what he thought of that. "The soil on which these plants (Lep. buc.) grow is the decomposing deposits of food which lie between the papillæ of the tongue and their processes." *Zwischenräumen* is the word that appears in the original.

Pouchet was the next who wrote upon this subject; his article appeared in 1864,* and marks an epoch in the history of the fungus. It ascribes the granules to neither food nor epithelium, but suggests that they constitute "un état du végétal." As the paper is short, I will copy it *in extenso*:—

"Jusqu'ici le Leptothrix buccalis a été décrit comme naissant sur un stroma granuleux formé de matières

* *Gazette Médicale de Paris*, 1864. *Du Leptothrix Buccalis*, par M. G. Pouchet.

animales en putréfaction, au milieu duquel on peut apercevoir des vibrions, et qui constituerait pour l'algue parasite un véritable terroir. Nos observations nous ont conduit à envisager tout autrement ce stroma. En étudiant des langues dont l'épithélium tout entier se renouvelle à la fois dans certaines maladies, on peut découvrir, sur les extrémités flabelliformes de certaines papilles caliciformes, de petites masses de matière granuleuse absolument semblables à celle du stroma décrit comme terroir du Leptothrix. Ces masses, qu'on peut étudier au début, quand elles n'ont encore que $0^{mm.}$ ·030 à $0^{mm.}$ ·050 de diamètre, offrent ceci de particulier, d'être nettement limitées, sur le point où elles n'adhèrent pas au tissu épithélial, par une ligne de contour très-fine et très-distincte qui enveloppe les granulations: en sorte que l'ensemble rappelle assez bien ces œufs que certains gastéropodes aquatiques déposent sur les herbes des mares. Ce contour éloignerait seul toute idée de matière animale morte; mais on voit très-bien que cette masse granuleuse grandit jusqu'à envelopper toute l'extrémité flabelliforme de la papille. Elle peut même coiffer celle-ci, et dans ce cas, la masse granuleuse, toujours terminée par une ligne de contour extrêmement fine et distincte, rappelle assez bien une petite vessie à couleur qu'on aurait piquée par le goulot sur un poinçon. Il suit de là que cette matière granuleuse n'est point un terroir pour le Leptothrix, mais bien un état du végétal. Celui-ci, sous cette forme, grandissant toujours, tend à envelopper totalement la papille, et c'est alors qu'il donne naissance aux

filaments décrits depuis longtemps. En même temps la périphérie de la masse granuleuse perd son contour, soit par les actions de frottement, soit par la mort partielle de la masse elle-même. Et c'est évidemment dans ce dernier cas seulement qu'on a pu y voir des vibrions."

Not only do I agree with Pouchet in thinking that this granular matter, instead of forming merely a soil from which the fungus grows, is really a part of the plant itself; but I believe also that it consists essentially of spores, which, when elongated, constitute the well-known filaments.

I shall now describe the specimens which may be obtained of this fungus, and which, I think, fully bear out the opinion I have ventured to express.

On examining some of the epithelium scraped from the posterior part of the dorsum of the tongue, there will be seen, together with other objects, some like that represented in Fig. 1. These are the bodies referred to by Pouchet; their margins are uniform and uninterrupted, unless accidentally broken during the preparation of the specimen; and their general aspect is granular, except in the centre, which consists of epithelium. They correspond to the "brown, elongated bodies" referred to by Kölliker, though without the filaments, of which they are said to form the "matrix." On adding tolerably strong acid or alkali, these bodies break up more or less completely; the central part is seen to consist of epithelium, whilst the granular portion separates into particles, of round and oval shape, which vary in size, and resist

the action of ether. Perhaps more epithelium than was previously visible will be brought into view, and it is, of course, rendered dim by the reagent. The specimen shown in Fig. 2 is got from the same source as that just described, and differs, first, in being more coarsely granular; secondly, in having lost its uniform outline, having instead one which may be described as serrated or ciliated; thirdly, in breaking up, under reagents, into particles more elongated than those in the former case. The central epithelial part presents no difference.

Is it not likely that this second specimen represents merely an advanced stage of the first? If so, on what does the difference depend? Merely on the elongation of the granules, which have become metamorphosed into fibres shorter than, but otherwise like, those seen in Fig. 3. At the edge, the fibrillar structure is evident; whilst at other parts the mass appears granular, because the fibres, being short and set vertically, are seen in section as it were.

In Fig. 3, the fibres are of tolerable length, but, as in the other cases, grow from, and are attached to, epithelium.

Figs. 1, 2, and 3, therefore, represent the same fungus in different stages of its growth. In the first, the spores are still round or oval; in the second, they have become slightly elongated; and in the third, developed into fibres, of which some have attained considerable length.

In Figs. 4 and 5 we have another, and, to the best of my knowledge, hitherto unnoticed, arrangement of

the spores. They (spores) are now seen grouped round fibres, which, singly or in bundles, are thus completely covered. The bundles vary much in size, and show the structure (fibrillar) of their centres most clearly when the layer (spores) is thin. At intervals the spores may be detached, and the fibres, there exposed, are seen more plainly than elsewhere. At the extremity of a branch this frequently occurs. At Fig. 4 B, a branch is seen in section. In Figs. 4 A and 6 A B, the spores, arranged round fibres, have themselves developed into fibres, and the branches resemble much those of a fir in miniature.

An important question now suggests itself as to the source of the spores, and their appearance when first appreciable. To Robin's opinion on this subject I have already had occasion to refer. He describes, within the ordinary tubes, granules (very difficult to recognise) which may possibly escape and constitute the spores. Küchenmeister, on the other hand, depicts* some special and spore-bearing fibres, which, though having an equally defined outline, are larger than the common ones, and have, in their interior, granules of considerable size. Did Robin overlook these filaments; or does Küchenmeister represent them wrongly?

I long noticed, but could not account for, certain fibres, such as are shown in Fig. 6 C. They were broader than the common filaments of the Leptothrix buccalis, and wanted their clear and well-defined

* *Parasites of the Human Body.* Syd. Soc. (See Plates.)

outlines. Their aspect, moreover, was not homogeneous, but finely granular, like ground glass: even under a high magnifying power it was difficult to make out distinct granules. After a long and unsuccessful examination of these fibres, I discovered one such as is represented in Fig. 6 D: one half resembles the ordinary filaments of the fungus, whilst the other is like those I have just described. At the junction of the two it is easy to perceive the arrangement of a finely granular material upon a common fibre of the Leptothrix buccalis. There also exist fibres such as are shown in Fig. 6 E. These differ from the last in having distinct granules, and represent, I think, a more advanced stage. I am inclined to believe, therefore, that the spores of the Leptothrix buccalis, at an early stage, form, when collected together, a layer which, though highly magnified, presents an *almost* homogeneous look; but whether they escape from the interior of the tubes I am not in a position to decide. In confirmation of this view, I may observe that bodies are occasionally seen which differ from that shown in Fig. 1 only in the greater fineness of the granules. Such structures resemble those in Fig. 6 C, except that the spores are placed on epithelium instead of round a fibre. Figs. 6 E and Fig. 1 are related to each other in a similar manner; the spores have become larger, and are now cognizable as distinct granules, though, as in the former instance, they are grouped, in one case round a fibre, and in the other upon epithelium.

Are these (Fig. 6 E) the fibres which Küchen-

meister has observed? In the drawing he has given, the granules are placed singly and at equal intervals, whilst in the fibres just described they are scattered most irregularly. The want of clearness in the margins and homogeneousness between the granules further separates these filaments from Küchenmeister's.

Again, once upon the human teeth, and oftener upon those of the dog, I have detected filaments, with well-defined margins, and large granules in their interior. They are larger than the fibres of the Leptothrix buccalis, not pointed at the ends, and without articulations. So far they agree with the spore-bearing fibres drawn by Küchenmeister, but they differ in the number and irregular arrangement of the granules. I believe them to be fibres of the Leptothrix insectorum.

To sum up what has been said respecting the nature of the granules, I believe them, and for the following reasons, to consist of spores:—

1st. They resemble the spores of certain other fungi, except in point of size; thus, if contrasted with those of the *Oïdium albicans*, they behave in the same manner towards reagents, and differ only in being smaller; but the filaments are also smaller, so that the relationship between spores and mycelium remains unaltered.

2ndly. The mode of arrangement, both upon epithelium and fibres, is suggestive of spores rather than of *débris*. If the granular matter consisted of the latter, there would be seen, at any rate occasionally, tolerably

perfect specimens of the material from which it was derived; for degeneration must be far advanced before all traces of the original structure are destroyed. The even and unbroken outline of the mass also renders it impossible that this material can come from either food or epithelium. (Pouchet.)

3rdly. Specimens may be obtained which illustrate all stages intermediate to that, in which the spores are hardly cognizable as distinct bodies, and that in which they have developed into long and perfect fibres.

I have endeavoured, by maintaining a proper temperature, to watch the growth of the plant under the microscope, but difficulties of manipulation have rendered my efforts at present unsuccessful.

From what has been said, it will be now intelligible how a large quantity of granular matter, consisting really of spores, has, in the concretions of the tonsils, been mistaken for something else. Were further proof required, beyond a microscopical examination, to establish the parasitic nature of these bodies, it would be supplied by their peculiar fetor. This has been noticed by all who have written on the subject, and is observed before the concretions have begun to decompose. On the other hand, it resembles that of the softish white matter which forms upon the teeth, sound or otherwise, of all persons, whether in health or not; and which, I need hardly say, consists entirely (or almost so) of the Leptothrix buccalis. This fungus forms a part also of the fur of the tongue. Fragments of the fibres have been detected not only

in the vomit, but also in the fæces;* though it is probable that, even in these cases, the fungus has originated in the mouth, and afterwards been swallowed. Such an occurrence must take place constantly. In further confirmation of the theory that these concretions consist of something else than the secretion of the tonsils, I may observe that in a girl now under my care for an affection of these glands, I have removed concretions from a small recess, above the tonsils and where the two pillars of the palate meet. At this spot there is no true tonsil tissue.

The concretions of the tonsils sometimes calcify; one, in this state, analysed by Laugier, was greyish-white, rather hard, verrucose, and consisted of a rough crust and a white nucleus. It contained†—

Phosphate of lime	50·0
Carbonate of lime	12·5
Mucus	12·5
Water	25·0
	100·0

Amongst the ingredients of the concretions I enumerated two sorts of filaments; one (Leptothrix buccalis) I have described, and will now say a few words respecting the other.

In the white matter which forms upon the human teeth, there will be seen, with long fibres of the Leptothrix buccalis, others which are shorter; these latter quite resemble, and are doubtless only fragments of, the former. In the concretions of the

* See Robin's *Histoire Naturelle des Végétaux Parasites.*
† Vogel's *Pathological Anatomy*, translated by Day.

tonsils there are also fibres which are short, and, like those upon the teeth, have a homogeneous aspect and margins well defined; *but their diameter is greater.* For some time I regarded these as merely pieces of the longer fibres of the Leptothrix buccalis; but perceived, when examining a concretion immediately after its removal from a living person, that they were gifted with the power of independent motion. As they moved from place to place they reminded me of eels; but between their two extremities I could detect no difference of either size or structure. Some may be seen to move in one direction, and then go backwards without turning round. They are doubtless what Dr. Biermer has described.* His observations are as follows: "Another form of cryptogamic growth which may be observed in *sputa* is that composed of threads, formerly thought to be infusoria, and called *vibrio lineola*; under treatment with sulphuric acid they appear jointed; on account of their spiral movement they have been considered animals. A few hours after meals they may generally be found in the mouth, as products of disintegration." Leeuwenhoek, as early as 1722, had evidently observed the same, and experienced a difficulty in distinguishing them from filaments of the Leptothrix buccalis. He observes, when speaking of the latter:† "Porro constabat maxima pars materiæ ex immensa striarum multitudine; quarum quidem una ab alia longitudine plurimum differebat, unius tamen ejusdem erant

* *Die Lehre vom Auswurf.* von Dr. Anton Biermer.
† *Arcana Naturæ Detecta.* Lugd. Bat.

crassitiei, aliæ incurvatæ, aliæ rectæ, ut in hac Fig. F. quæ sine ordine jacebant; *et quia antehac animalcula eamdem habentia figuram vidi in aqua viventia, idcirco omni molimine contendi ut observarem utrum in illis esset vita*; sed nullum motum, ex quo minimum vitam conjicerem, potui animadvertere."

As further showing how much doubt attaches to this subject, I will quote the observations of another well-known writer:* "Closely related to these (fibres of Leptothrix buccalis) are certain fibrillose and very numerous corpuscles without any transverse division or branching. They are thicker than the last, and about 0·014 to 0·024mm. long. They have a great tendency to break up transversely. They are neither soluble in ether or alcohol, nor are they changed by heat or the caustic alkalis and mineral acids. These are perhaps the filaments found free in the saliva by Lebert. According to Wedl their nature is unknown, and he suggests they may be vibrios. Their envelopes, according to him, are composed of silicic acid, whilst Bühlmann maintains they contain fluoric acid. This resistance to reagents does not, however, appear to be opposed to their vegetable nature, as we know that many plants contain sufficient silica to resist the action of heat."

The transverse splitting of these fibres is peculiar, and rather difficult to understand; it is not constant, nor can I ascertain what conditions predispose to it; the appearance of articulation, to which Biermer has

* Küchenmeister's *Parasites of the Human Body.* Syd. Soc.

referred, is preliminary only, and not produced at all times by the action of sulphuric acid.

Lebert has figured these bodies mixed with common vibrios, with which he evidently classes them; his drawing shows them as they are when moving—viz., of an undulating form—for after death they are either straight or have a single curve. The common vibrios are also represented as they look in life—viz., pointed at one end. This appearance is deceptive, and depends upon the objects lying in a plane between the vertical and horizontal; for when, their movements having ceased, they lie horizontally, it is evident their diameter is uniform throughout.

There is a marked difference between the movements exhibited by the common vibrios and by the larger objects we have just described. Of these, the former move quickly on themselves, without escaping far from a particular locality; whilst the latter shift from place to place with a slow and eel-like motion.

Of the effect produced upon the tonsils by concretions formed within them, I am able to add little to what Trousseau has observed:* "Il est une autre forme d'angine que je vois peu décrite dans les livres classiques, et dont je vous ai montré quelques exemples dans le service de la Clinique. Il arrive souvent chez les malades atteints d'inflammation chronique habituelle des amygdales, que les sécrétions des lacunes qui séparent les lobules de la glande s'altèrent et s'épaisissent; il se forme de petites masses caséiformes irrégulières fétides. Elles agissent comme un corps étranger, déterminent une vive inflammation, une douleur très aiguë, et souvent, vous vous le rappellez, il vous a été donné de voir la pointe de ces petits corps faire saillie à la surface des tonsilles. Ils sortent enfin après avoir causé de vives souffrances, et une ulcération superficielle, à moins que le médecin lui-même, en pressant énergiquement, ne fasse sortir la petite masse, et ne termine en un instant cet angine si douloureuse et si peu grave. *L'ablation des amygdales est certes le meilleur remède que l'on doive conseiller aux malades qui éprouvent très fréquemment cette indisposition.*"

* See *Clinique Médicale*, tome i.

I would further notice, that concretions may arise, not only when the tonsils are enlarged, but even when they are as small as or smaller than the average. Moreover, the degree of inconvenience produced depends much upon the conformation of the tonsils. In some, though the sinuses are large, they open in the throat by very tiny openings; so that a concretion may increase, whilst it cannot be expelled except when broken up. In others, the apertures are wide, and the concretion then escapes with tolerable ease. Potassa fusa serves better than the knife for the treatment of those cases in which, though the tonsils are quite small, concretions are produced, and cannot be got rid of till the openings are enlarged.

While the above paper was in press, Dr. Beale informed me that he had long been of the same opinion as myself respecting the nature of the

granular matter; and on referring to his work on Urinary Diseases—published as early as 1856—I find there (Plate 1) a figure (2) showing a few scattered granules and some oral epithelium, the former of which he describes as 'Sporules of fungi.'

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RESEARCHES

ON

THE DAILY EXCRETION OF UREA IN TYPHUS FEVER,

WITH REMARKS.

BY

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RESEARCHES

ON THE

DAILY EXCRETION OF UREA IN TYPHUS FEVER.

GREAT importance has been attached to the amount of urea formed and excreted in fevers: 1*st*, In regard to the prevalent doctrine, that fever consists essentially in an increased metamorphosis of tissue; and, 2*d*, In regard to the question, how far the comatose or head symptoms of fever are due to a retention of urea in the system (uræmia). Although these points have been made the subject of chemical investigation in the typhoid or enteric fever, chiefly on the Continent, they have not been hitherto sufficiently tested by similar observations in the more common fever of Britain, the epidemic typhus. The only analyses of the *whole* urine, in cases of typhus, which I have been able to find, are those of one case by Dr Parkes,[1] and, since my own observations were made, of two by Mr Dunnett Spanton.[2] The analyses of urine in so-called typhus, published by Becquerel and others, there is every reason to suppose, refer in reality to examples of typhoid fever. Barralier[3] has published analyses of the urine in several cases of true typhus; but the experiments were made on limited quantities of the urine, and the amounts excreted daily are not given. It is obvious, therefore, that there is a deficiency of accurate knowledge, based on observation, of the relations of urea to typhus fever. To supply this want, in some degree, was my object. I have confined myself to the determination of the amount of urea excreted daily in six cases of undoubted typhus, presenting the characteristic eruption, and I have omitted several cases in which the diagnosis was doubtful. The total amount of the daily urine was carefully collected, measured, and analyzed for urea by Davy's process.[4] My best thanks are due to

[1] Medical Times and Gazette, 1857, Feb., and Parkes on Urine.
[2] Medical Times and Gazette, 1864.
[3] Du Typhus Epidémique à Toulon.
[4] London, Edinburgh, and Dublin Phil. Mag., June 1854. Also, Beale on Urine, etc., 2d Edition, p. 21.

Dr Sanders for his kindness in permitting me to make the observations on his patients in the Royal Infirmary; to Professor Maclagan, for the valuable privilege of performing the analyses in his laboratory; and to Dr Arthur Gamgee, to whom I am indebted for my knowledge of the chemical processes required.

The general results of the inquiry have been that, *in all of the cases the quantity of urea excreted daily, during the second week, was decidedly below the standard of health*, notwithstanding that the patients were in a state of high fever, with the temperature and the pulse much above the normal rate. These results differ markedly from those of Dr Parkes' analyses, and are opposed to the belief which many entertain of an increased excretion of urea in typhus. With regard to the daily excretion, during the first week, nothing definite could be made out, as the patients entered hospital at too late a period of the fever to admit of a sufficient number of observations. In three of the cases, however, viz., Cases 1, 4, and 6, the excretion of urea was found to be comparatively high at the end of the first week, but not above the normal amount.

The cases may be divided into two classes; one, in which the crisis occurred on the fourteenth day, while the nervous symptoms continued to some extent for a day or two longer; the other, in which the crisis took place by a process of gradual improvement, beginning about the tenth or eleventh day, and completed about the fourteenth. To the first class belong Cases 1, 2, 4, and 5; to the second, Cases 3 and 6. In the *first* class, an increased discharge of urea took place at, and immediately after, the crisis. Subsequently to the occurrence of this increased discharge, the daily excretion of urea fell to a very low amount, and then rose gradually as the patient improved in health. In the *second* class, the nervous symptoms abated about the tenth or eleventh day, after an increase in the excretion of urea. The completion of the crisis on the fourteenth day was followed by a fall in the amount of urea excreted daily, which then gradually rose with the return of health, as in the other class. To illustrate the distinction between the two classes, I have appended a diagramatic view of the range of the daily excretion of urea in a specimen of each class.

In his Gulstonian Lectures on Pyrexia, Dr Parkes has shown that the febrile condition is attended by increased metamorphosis of tissue, and, in consequence, by an augmented formation of urea. It also appears from his observations that this increased formation of urea is not necessarily followed by an increase in the quantity eliminated, but that, in certain circumstances, a considerable amount of urea may be retained in the system. In my cases, such a retention seems to have taken place, since an increase of urea was observed, as before mentioned, either on the occurrence of crisis, or on the appearance of the first symptoms of improvement. That this increased excretion was due to a previous retention, and not to a more active tissue-metamorphosis, consequent on the improvement in the condition of

the patient, is rendered probable by the fact, that the excretion of urea was greatly lowered after the sixteenth or seventeenth day, and rose in amount exactly in proportion to the rapidity with which the patients regained health and strength; and also by the fact of the excretion having been very low for some time previous to its increase.

It is generally admitted that in Bright's disease and cholera, and in many other affections, stupor, delirium, and other nervous symptoms of a low or so-called "typhoid" character, are due to a retention of urea. In regard to the head symptoms of typhus, a similar explanation has been proposed. In my cases, the fact of those symptoms being most intense while the urea-excretion was lowest, and of their improvement coinciding with, or following on, an increase in that excretion, appears to favour this view very strongly. In two of the cases in which the increased elimination took place on the days immediately following the fourteenth, the nervous symptoms continued to a considerable extent during those days, although the fourteenth had evidently been the critical day. In the cases in which the increased elimination took place before the fourteenth day, no delirium was observed after the occurrence of the increased discharge. The probability of this theory is strengthened by the fact that the other symptoms retained their febrile character, in the latter class of cases, till the ordinary period of crisis.

On the other hand, it may be argued that the retention of urea was merely a consequence of the abnormal condition of the nervous system, and not in any way a cause of that condition. This view would appear to derive support from my cases, in so far as, in the majority of them, the increased elimination did not take place till *after* the crisis had begun; but I think this support is more apparent than real, as, in half of these cases, the nervous symptoms continued to a considerable extent during the occurrence of the increased elimination, and did not finally disappear till the urea had fallen to the low standard natural in the enfeebled state of the patients.

It is very difficult to say why, failing organic lesion of the kidneys, urea should be retained, or why it should be retained to a greater extent in some cases than in others. Perhaps the retention is due to a defective innervation; the theory at present entertained, that in fevers there is a degree of paralysis of the nervous system, gives countenance to such a view.

In submitting the facts observed, I shall give a short abstract of each case, followed by the detailed statement of the condition of the urine, which I have put in a tabular form for convenience of reference and comparison. Details of the daily symptoms of the cases are, for the sake of completeness, added, in the form of an appendix, at the end of the paper.

I have calculated the total solids by an empirical formula of Dr Christison,[1] the results of which are a sufficiently close approximation to the real amount.

[1] Tweedie's Lib. of Med., vol. iv. p. 248.

Before giving the results of my analyses of the urine, it may be well to note the amount of urine and of urea which is considered to be natural to adults in a state of health. Parkes[1] estimated the normal quantity of urine at about 52½ ounces, and of urea at 33·18 grammes, or 512·4 grains, and, although other writers have calculated both at a much higher rate, this estimate may be assumed as sufficiently accurate for comparison. Women excrete less both of urine and of urea than men. Parkes estimates the average excretion of urea in women at from 16 to 28 grammes (246·9 to 432·1 grains) per diem, but says that it may vary from 12 to 30 grammes (185·2 to 463 grains).

Case 1.—A domestic servant, æt. 19, admitted on the third day of the fever. Her case was a serious one, the nervous symptoms being very severe, as shown by extreme restlessness, panting respiration, moaning, and crying, during the first week; and afterwards by an extreme degree of oppression and stupor, by very violent tremors and subsultus of both hands and feet, and by retention of urine at one time, and its involuntary discharge at another. Convalescence occurred on the fourteenth day, but a considerable degree of oppression and stupor remained for two days after that date. The pulse was remarkably low during the second week of the fever.

Days of the Fever.	Urine.		Urea.		Sp. Gr.	Reaction.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes.	In Grains.			
5	580	20·4	27·37	422·31	1026·0	Neutral.	554·4
6	915	32·2	5·79	89·36	1028·6	Neutral.	944·4
7	600	21·1	5·31	81·95	1026·9	Neutral.	573·4
8	585	20·6	4·04	62·35	1023·7	Neutral.	493·8
9	1240	43·7	5·31	81·95	1025·4	Slightly acid.	1141·4
10	845	29·8	3·39	52·32	1020·2	Slightly acid.	619·5
11	Urine not collected.						
12	540	19·0	1·17	18·05	1018·5	Acid.	354·7
13	820	28·9	4·29	66·21	1023·5	Slightly acid.	662·0
14	640	22·5	2·68	41·36	1024·9	Acid.	563·6
15	Urine not collected.						
16	1170	41·2	18·69	288·46	1020·2	Acid.	856·5
17	520	18·3	2·28	35·18	1018·6	Neutral.	341·6
18	760	26·8	8·47	130·72	1019·6	Acid.	528·7
19	965	34·0	8·51	131·34	1018·3	Neutral.	634·7
20	1150	40·5	9·74	150·32	1013·7	Slightly acid.	543·5
21	780	27·5	11·24	173·47	1016·6	Acid.	455·6
22	1540	54·3	20·73	319·94	1015·3	Neutral.	842·7
23	1500	52·9	16·19	249·87	1014·5	Acid.	765·4
28	1670	58·9	23·45	361·89	1018·1	Slightly acid.	1099·6

Case 2.—A labourer, æt. 30, a strong, tall man. He was admitted to hospital on the eighth day of the disease. The case was

[1] Parkes on Urine.

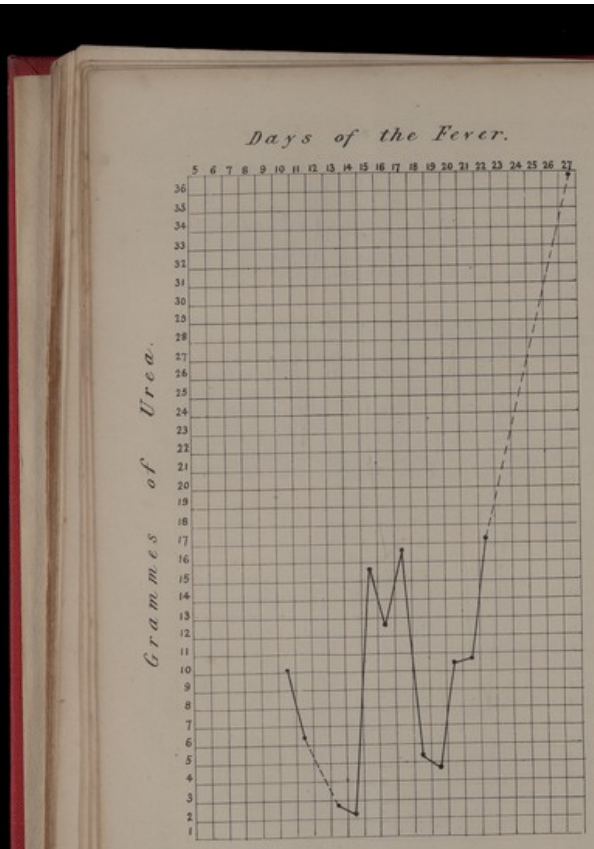


DIAGRAM OF THE DAILY EXCRETION
OF UREA IN CASE II.

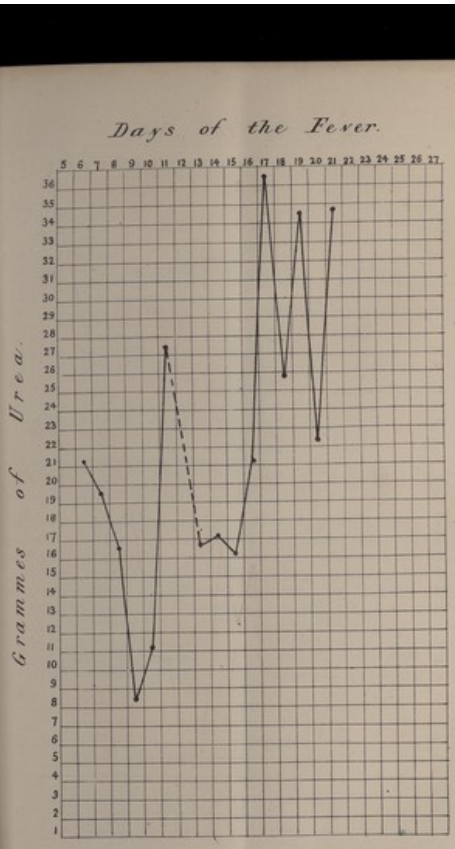


DIAGRAM OF THE DAILY EXCRETION
OF UREA IN CASE VI.

one of moderate severity. Convalescence commenced on the fourteenth day, but the typhoid stupor continued, to some extent, for a day or two longer.

Days of the Fever	Urine.		Urea.		Sp. Gr.	Reaction.	Albumen.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes	In Grains				
9	1145	40·3			1020·7	Neutral.		837·8
10	585	20·6	10·04	154·95	1019·5	Neutral.	Considerable.	406·4
11	745	26·2	6·49	100·16	1015·8	Neutral.	Considerable.	375·6
12	Urine not collected.							
13	835	29·4	2·66	41·05	1015·8	Slightly acid.	Considerable.	456·2
14	950	33·5	2·27	35·03	1017·7	Acid.	None.	590·2
15	1450	51·1	15·89	245·24	1014·8	Acid.	None.	739·4
16	1340	47·2	12·63	194·93	1012·3	Acid.	None.	585·8
17	1450	51·1	16·69	257·59	1014·1	Acid.	None.	739·4
18	1460	51·5	5·37	82·88	1020·2	Acid.	None.	1070·6
19	960	33·7	4·71	72·69	1023·0	Acid.	None.	808·1
20	1050	37·0	10·42	160·82	1023·7	Acid.	None.	887·2
21	1225	43·2	10·72	165·45	1023·2	Acid.	None.	1035·9
22	1260	44·4	17·18	265·15	1020·9	Acid.	None.	923·0
23	1585	55·9			1019·0	Acid.	None.	1102·9
24	1800	63·4	Urine not examined.					
27	2315	81·6	37·29	575·53	1017·1	Acid.	None.	1437·7
32	2640	93·1	36·46	562·72	1016·4	Feebly alkaline.	None.	1542·6

Case 3.—A labourer, æt. 40, a tall, very powerful man. This case was a mild one in many respects, the patient being singularly intelligent for a case of typhus, uniformly sleeping well, and never having any nearer approach to delirium than a slight wandering of the mind, and that on only a few occasions. On the other hand, the pulse was rapid, the temperature high, and there was considerable subsultus from the time of his admission (eighth day) till an advanced period of convalescence. The case was one of those in which a gradual improvement was observed for several days before the actual occurrence of crisis. He convalesced on the fourteenth day.

Days of the Fever.	Urine.		Urea.		Sp. Gr.	Reaction.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes.	In Grains.			
8	540	19·0	6·82	105·2	1023·3	Acid.	455·6
9	920	32·4	13·88	214·2	1021·3	Acid.	707·9
10	1540	54·3	23·92	369·1	1015·1	Acid.	842·7
11	1270	44·7	21·56	332·7	1015·1	Acid.	693·7
12	790	27·8	11·70	180·5	1024·3	Acid.	696·3
13	650	22·9	11·58	178·7	1026·4	Acid.	622·4
14	700	24·6	10·74	165·7	1022·6	Acid.	563·5
15	600	21·1	7·94	122·5	1025·6	Acid.	551·1
16	770	27·1	13·09	202·0	1024·7	Slightly alkaline	678·8
17	850	29·9	20·76	330·4	1023·5	Slightly acid.	690·0
18	850	29·9	11·20	172·8	1023·9	Acid.	690·0

Case 4.—A baker, aged 14, a very weakly lad, who had just recovered from typhoid fever, having been up only a fortnight when he took typhus. The case was by no means a very severe one. He slept tolerably well, and the nervous symptoms were not strongly developed. He convalesced on the fourteenth day.

Days of the Fever.	Urine.		Urea.		Sp. Gr.	Reaction.	Albumen.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes.	In Grains.				
5	740	26·1	7·66	118·2	1025·2	Acid.	None.	681·7
6	450	15·8	4·02	62·0	1027·1	Acid.	Slight.	446·4
7	920	32·4	21·7	335·0	1020·0	Acid.	Slight.	673·5
8	655	23·1	9·31	143·6	1015·1	Acid.	Considerable.	364·5
9	395	13·9	4·46	68·8	1013·8	Neutral.	None.	186·5
10	370	13·0	4·32	66·6	1013·0	Neutral.	None.	174·4
11	590	20·8	7·67	118·3	1010·6	Feebly acid.	Considerable.	338·2
12	835	29·4	13·15	202·9	1010·9	Neutral.	Considerable.	302·2
13	650	22·9	8·86	136·7	1020·1	Neutral.	None.	416·0
14	Urine not collected.							
15	990	34·9	15·68	242·0	1012·3	Alkaline.	None.	431·7
16	850	29·9	14·72	227·1	1013·1	Alkaline.	Considerable.	401·2
17	390	13·7	5·87	90·5	1013·0	Acid.	Very slight.	183·8
18	630	22·2	10·14	156·5	1012·8	Acid.	None.	274·6
19	750	26·4	13·08	201·8	1013·1	Acid.	None.	360·2

In a case like the above, where the patient was weak and emaciated from a previous illness, one would expect a much lower excretion of urea than in a previously healthy, robust man. The age of the patient (14) must also be considered. From two analyses, one by Uhle, the other by Bischoff,[1] it would appear that the natural excretion of urine in boys from 13 to 16 years of age, in a state of health, is about 25 or 26 ounces, and of urea, from 180 to 190 grains. These analyses are, however, too few in number to be absolutely relied upon. Few researches seem to have been made to ascertain the influence of youth on the quantity of urine and of urea excreted daily in a state of health. I have failed to find the record of any other analyses bearing on this point than the two quoted above.

Case 5.—A tailor, aged 46, of a somewhat delicate constitution. This case was, towards the crisis, complicated with pneumonia. After the twelfth day the urine became alkaline and deposited phosphates, and this condition continued till the patient had fully regained health. He convalesced on the fourteenth day, but the stupor and other nervous symptoms continued for a day or two longer. The pulse was unusually low during the fever. The temperature varied from 103° to 104° Fahr.

[1] Referred to in Parkes on Urine, 1860, p. 44.

Days of the Fever.	Urine.		Urea.		Sp. Gr.	Reaction.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes.	In Grains.			
8	570	20·1	4·85	74·85	1027·6	Acid.	568·0
9	545	19·2	9·80	151·2	1026·2	Acid.	521·8
10	835	29·4	15·59	240·6	1025·5	Acid.	767·9
11	1050	36·9	...	...	1031·3	Acid.	1201·8
12	900	31·7	15·95	246·1	1017·8	Acid.	558·5
13	1230	43·3	18·38	283·6	1019·9	Alkaline.	854·3
14	910	32·0	14·8	229·6	1019·6	Acid.	631·3
15	1150	40·5	24·4	377·3	1020·3	Alkaline.	841·9
16	890	31·3	...	...	...	...	...
17	1020	35·9	17·05	263·1	1020·4	Alkaline.	746·3
18	925	32·6	11·22	173·1	1015·4	Alkaline.	505·9
19	965	34·0	11·43	176·4	1020·8	Alkaline.	706·8
20	845	29·8	15·80	243·8	1028·1	Alkaline.	874·0
21	655	23·1	11·64	179·6	1026·2	Alkaline.	627·8

Case 6.—A baker, aged 20, a stout young man. This was a very mild case, in which crisis occurred imperceptibly about the fourteenth day. Previous to that period, however, the symptoms underwent a marked improvement. The temperature continued high till the fifteenth day. The urine was more or less alkaline during the whole progress of the case. In this case, wine was administered towards the crisis.

Days of the Fever.	Urine.		Urea.		Sp. Gr.	Estimated Total Solids in Grains.
	In Cubic Centimetres.	In Oz.	In Grammes.	In Grains.		
6	1260	44·4	21·26	328·1	1027·4	1254·7
7	1190	41·9	19·62	302·8	1031·5	1364·6
8	1050	36·9	16·65	256·9	1025·2	963·8
9	795	28·0	8·40	129·6	1033·5	1021·0
10	1500	52·9	11·19	172·7	1033·9	1785·3
11	1435	50·6	27·40	422·8	1020·9	1051·9
12	Urine not collected.					
13	1185	41·8	16·85	260·0	1023·4	1002·3
14	1045	36·8	17·15	264·6	1024·7	921·8
15	950	33·5	16·13	248·9	1024·1	859·2
16	1190	41·9	21·43	330·7	1025·8	1091·8
17	2190	77·2	36·42	562·1	1015·9	1198·1
18	2070	73·0	25·94	400·3	1017·4	1286·2
19	2320	81·8	34·59	533·8	1017·3	1441·3
20	1830	64·5	22·29	344·0	1013·8	865·5
21	2150	75·8	34·95	539·4	1017·1	1345·5

Appendix of Daily Notes of Cases.

Case I.—*3d day, Evening.*—Temp. 105°. Eruption abundant; panting respiration; tongue moist, coated with white fur; severe headache.

4th day.—Temp. 103°. Pulse 106, soft and of fair strength; a few wheezing râles over the chest; tongue red, with white fur; eyes suffused, pupils large;

sight and hearing impaired; headache gone; very restless all night, moaning and crying; a considerable degree of oppression.

5th day.—Pulse 104; tongue dry in centre, white at edges, yellow at back; restless through night, but slept towards morning; delirious and wandering during the night.

6th day.—Pulse 106; slight subsultus; stupid, but understands when spoken to; inclined to sleep; restless and wandering through the night, and sometimes did not know the nurse. Had retention, and urine was drawn off by catheter.

7th day.—Pulse 106; slept last night, after two doses of tinct. hyoscyami, ℥j each; restless and delirious towards morning.

8th day.—Pulse 90; tongue dry, and brown in centre, white at edges; slept at beginning of night, but talked and "rambled" later; now (1 P.M.) inclined to sleep; subsultus of hands; unwilling to speak; takes nothing but milk and water.

9th day.—Pulse 90; breathing easier; tremors of hands. Had ℥i of tinct. hyoscyami last night. Very restless all night; talking and "rambling" much; retention of urine this morning; understands when spoken to.

10th day.—Pulse 80, of fair strength; breathing occasionally hurried; tongue dry, brown, and fissured in centre, moist at the sides, sordes on teeth; inclined to sleep; very restless and delirious during the night; hands tremulous; complains of headache. Had a draught of 40 minims of tinct. hyoscy. with 20 minims of sol. mur. morph. last night; takes only a very little gruel.

11th day.—Pulse 74; nervous "sniftering" breathing; very restless, wishing to get out of bed; hands and arms trembling; fumbling at bed-clothes; sobbing occasionally; understands when spoken to; passing urine in bed.

12th day.—Pulse 84; tongue still dry in centre, but the moistness of the edges appears to be extending; less sordes on teeth and lips; was wildly delirious last night, and very anxious to get out of bed; still much nervous excitement, her hands trembling and her manner agitated; speaks sensibly enough, but is very confused; says she has a difficulty in speaking; appears to be getting the expression of convalescence.

13th day.—Skin moist; eruption gone; sudamina on the skin; tongue still dry and brown; no headache; dreamed a great deal; muttered much during the night; languid and stupid, but answers correctly; tremors and subsultus of hands and feet, and twitching of facial muscles; slept very little during the night. Ordered 10 grains of nitrate of potash, three times a-day. Eating very little.

14th day.—Pulse 88, soft and full; skin moist; tongue dry, glazed at edges; pupils dilated; inclined to sleep; cries out at times; more stupid, and does not answer questions; tremors and subsultus rather less than before; had a drachm of tinct. hyoscy. last night.

15th day.—Pulse 80; tongue dry, and glazed at tip, and still fissured; very languid, and does not answer questions; muscular tremors almost gone; inclined to sleep; rather quiet in first part of night, afterwards restless; passed urine in bed.

16th day.—Pulse 72; tongue moistening, still fissured; bowels constipated; slept well, and is inclined to sleep; is very confused, and contradicts herself when answering questions.

17th day.—Pulse 76; tongue moist, and covered with white fur, still fissured in the centre; no tremors; sleep disturbed by a purgative; still very languid; taking a little arrowroot and beef-tea.

18th day.—Pulse 76; tongue getting clean, it is moist and whitish; did not sleep well on account of repeated action of bowels; quite conscious and intelligent; eating rather more.

19th day.—Pulse 70; tongue moist; slept well; appetite improving.

20th day.—Pulse 83; tongue moist, whitish; bowels rather costive; somewhat restless during the night.

She continued rapidly to improve from this time, regaining her appetite and strength very quickly.

CASE II.—*9th day.*—Temp. 105°. Pulse 107; slept very little, but was not delirious; slight tremors of hands; great thirst and no appetite.

10th day.—Temp. 101°. Pulse 110. Other symptoms as before.

11th day.—Temp. 100°. Pulse 112, small and weak; great headache; slight tremors of hands; slept pretty well, but was delirious during the night; answers intelligently; eats very little.

12th day.—Temp. 104°. Pulse 108, weak; has a very stupid typhous appearance, but answers correctly; delirous during the night.

13th day.—Temp. 104°. Pulse 104; heart sounds weak; severe headache; inclined to sleep; delirious through the night; right pupil larger than left; answers correctly.

14th day.—Temp. 104°. Pulse 96; quieter during the night; very confused, but answers correctly, though slowly; severe headache; not so thirsty; decubitus on side (previously on back).

15th day.—Appearance much improved. Temp. 102°. Pulse 96, fuller and softer than before; pain in head; slept well, and was not delirious.

16th day.—Temp. 100°. Pulse 84; tongue moist; right pupil still dilated, but less so than before; slept well; expression bewildered.

17th day.—Temp. 98°. Pulse 70; no headache; giddy when he sits up; right pupil still dilated; eating more.

18th day.—Temp. 99°. Pulse 76; slept well; left pupil larger than right; eating well.

19th day.—Temp. 98°. Pulse 66; slept very well; head quite clear; wishes to rise. Diet full, with the exception of meat.

From this date he rapidly improved.

CASE III.—*8th day.*—Eruption fully out and very copious; pulse 135, weak; tongue moist, coated with yellow fur; bowels loose (from purgatives); very thirsty; no appetite; slight subsultus; severe frontal headache; confused, but answers correctly.

9th day.—Pulse 130; tremors and subsultus of hands; no delirium; headache as before; slept pretty well; eating very little, but drinking much.

10th day.—Temp. 103°. Pulse 128, "wandering" a little, but intelligent at visit; tongue dry, glazed at tip, brown and furred at back; bowels regular; very thirsty.

11th day.—Temp. 104¼°. Pulse 140; great tremors and subsultus; bronchitic râles over both sides of chest; headache on coughing; tongue dry and brown; bowels regular; slept pretty well; no delirium. Ordered 8 oz. of wine per diem.

12th day.—Temp. 103°. Pulse 110; great tremors and subsultus; no delirium observed; tongue dry, brown, and fissured; bowels regular; slept well.

13th day.—Temp. 103½°. Pulse 120; cough troublesome; sputum streaked with blood; quite intelligent; no delirium; slept very well; eating little.

14th day.—Temp. 100°. Pulse 100; tongue moist, with yellow fur; slept very well; quite intelligent; eating considerably more.

15th day.—Temp. 100°. Pulse 92; bronchitis much better; slept very well; still tremors; tongue moist.

16th day.—Temp. 98°. Pulse 80; tremors less; tongue moist, furred; bowels regular; eating pretty well.

17th day.—Temp. 99°. Pulse 80; cough almost gone; tremors nearly gone; tongue moist, and nearly clean.

18th day.—Temp. 98¼°. Pulse 98; very slight tremors; bowels loose.

He continued steadily to improve, and soon regained his strength.

CASE IV.—*5th day.*—Temp. 104°. Pulse 112; eruption distinct; tongue dry in centre, with white creamy fur; slept well; no delirium.

6th day.—Temp. 105°. Pulse 112; sleeping well; no delirium; taking a fair amount of nourishment.

7th day.—Temp. 104°. Pulse 108; tongue moist, yellow, fissured in centre; slept well; eating very little.

8*th day*.—Temp. 103°. Pulse 110; slept well, but was delirious during the night; delirious at visit.
9*th day*.—Temp. 103°. Pulse 104. Had a draught of tinct. hyoscyami last night, and slept well, and without delirium; eating little.
10*th day*.—Temp. 103°. Pulse 110; slept well, but was somewhat delirious; eating rather more.
11*th day*.—Temp. 102°. Pulse 100; slept well; no delirium.
12*th day*.—Temp. 103°. Pulse 116; slept well; no delirium observed; eating better; bowels regular.
13*th day*.—Temp. 102°. Pulse 96; slept well; appearance much improved, eating pretty well.
14*th day*.—Temp. 102°. Pulse 86; slept well; eating well; tongue moist, whitish, fissures nearly gone.
15*th day*.—Temp. 100°. Pulse 82; doing well. He continued to improve.

Case V.—7*th day*.—Eruption copious; temp. 104°; pulse 95; tongue moist, with white fur; no appetite; great thirst; bowels loose (from purgatives).
8*th day*.—Temp. 103°. Pulse 95; bronchitic râles over chest; severe headache; slept pretty well; tongue dry, with yellowish white fur.
9*th day*.—Temp. 104°. Pulse 96; headache not so bad.
10*th day*.—Temp. 103° Pulse 100; did not sleep well; headache bad; delirium during the night.
11*th day*.—Temp. 104°. Pulse 96; slept well; headache bad; delirious during the night; had retention of urine; tongue dry and brown.
12*th day*.—Temp. 103°. Pulse 100; headache still severe; tremors and subsultus; slept well.
13*th day*.—Eruption distinctly petechial; temp. 103°; pulse 88; slept well; bad headache; tongue dry and brown; eating very little.
14*th day*.—Temp. 103°. Pulse 88; headache better; tremors and subsultus; pupils contracted; slept pretty well; tongue moist, getting clean.
15*th day*.—Temp. 104°. Pulse 84; bronchitic râles over chest, and crepitation at right base; slept pretty well; beginning to show appetite.
16*th day*.—Pulse 76, of fair strength; physical signs much the same; slept well; headache on coughing; tongue moist, with yellow fur; bowels regular; eating little.
He gradually improved from this date, making, however, a very slow recovery.

Case VI.—6*th day*.—Eruption distinct; temp. 103°; pulse 84; severe headache; quite intelligent; tongue moist, with yellowish white fur; great thirst; bowels loose (from purgatives).
7*th day*.—Temp. 105¼°. Pulse 92; headache rather better; no delirium; bowels still loose.
8*th day*.—Temp. 105¼°. Pulse 92; slight cough; no headache or subsultus; slept well, but was slightly delirious during the night.
9*th day*.—Temp. 105°. Pulse 92; slept pretty well; low, muttering, stupid delirium.
10*th day*.—Temp. 104°. Pulse 116, very weak; answers correctly, but is very confused; delirious in early part of night; very thirsty.
11*th day*.—Pulse 104; very confused, but answers correctly; tongue moist, brown in centre; delirious in first part of night.
12*th day*.—Temp. 103¼°. Pulse 87; slight subsultus; slept well; no delirium; tongue dry, fissured in centre; ordered ℥vi wine daily.
13*th day*.—Temp. 103°. Pulse 80; no subsultus; intelligent; slept well; tongue dry and brown all over; eating rather more.
14*th day*.—Temp. 102°. Pulse 76; slept well; tongue moistening.
He improved rapidly from this date.

EDINBURGH: PRINTED BY OLIVER AND BOYD.

From the Philosophical Magazine for November 1865.

AN ACCOUNT
OF
THE WATER-BAROMETER

CONSTRUCTED AND ERECTED BY
ALFRED BIRD,
EXPERIMENTAL CHEMIST, BIRMINGHAM.

[With a Plate.]

To the Editors of the Philosophical Magazine and Journal.

Gentlemen,

At the Meeting of the British Association which has just been held at Birmingham, I had the pleasure to show a water-barometer which has been in perfect action for six years. A general desire having been expressed that some account of the instrument should appear, I have the pleasure to send you the following particulars and drawings.

In the construction of a water-barometer four things have to be attended to:—

1st. The water must be deprived of air;

2nd. The air must not again enter the water;

3rd. The water must go into the barometer, to the exclusion of the air; and

4th. The instrument must be so constructed that, while the atmospheric pressure within the instrument shall be uninterrupted, no air shall penetrate into the vacuum-chamber.

I begin by describing the material. The tube is composed of metal and glass, and the three taps are those which go by the name of "Lambert taps." The size of the metal part is half an inch internal diameter, and is that sort of white-metal tube which is in universal use by gas-fitters, called "compo." I believe it is an alloy of lead and zinc.

I recommend that which is made by Messrs. Stock Brothers and Co., in Birmingham, as their compo tube will stand an internal pressure of fifty pounds of air to the inch without leaking: it is also very cheap. The glass tube to show the "readings" is 1 inch internal diameter and 6 feet long. The brass Lambert taps are half an inch internal diameter. These taps are constructed internally with a cushion of india-rubber, pressed down by means of a brass plate acted upon by a screw, which makes them absolutely secure.

I now proceed to describe the upper and lower parts of the barometer in reference to the drawings. Plate IV. A A is the compo tube, having two enlarged sockets B, B, 1½ inch in diameter and 3 inches deep. These sockets were made of brass, and their office is to receive the ends of the glass tube. To fix the glass tube C, about six inches of the compo tube was soldered to the bottom of the socket, and being inverted and fixed very steady, enough dry sand was poured into the compo tube to fill it up to the *bottom* of the socket B. The using of the sand was to prevent the cement from running into and stopping up the compo tube. The glass tube C, perfectly clean inside, was now placed in the socket; and being most carefully steadied to keep it upright, six inches of dry sand were poured down to keep the cement from rising up the glass tube C.

The cement was composed of two parts of gutta percha and one part of common black pitch. These two substances were heated in an iron ladle with a lip, till they became perfectly fluid and quite free from froth. A "copper bit" used by plumbers having been heated to low soldering-heat, a small quantity of the cement was poured into the socket. The copper bit was then applied to the outside, the effect being to perfectly liquefy the cement *in situ*. A little more of the hot cement was then poured in, and again the heated copper bit was applied till the socket was quite full of very fluid cement without any air-cavities therein. As the cement cooled, it clung to the glass and metal, and became absolutely solid and air-tight. If the cement is poured in *all at once*, it is impossible to prevent crevices, which will let in air when the barometer is filled, causing the water gradually to descend till it falls out of the instrument.

A place being chosen on the staircase of my house, a flat board, 7 feet long and 1 foot wide, was fastened to the wall, upon which board was fixed the socketed glass tube C, and graduated scale F, from the top of which 422 inches were most carefully measured down to the "zero"-point E beside the cistern.

The scale F is to the right of the glass tube. It is made of well-seasoned boxwood, and is graduated to inches and tenths. The sliding-tube G, with the vernier H, is between the glass tube and the boxwood scale F. On the left side of the glass tube C is another sliding-tube *g*, with a vernier *h*, to record position of top of tidal column of water at 9 A.M. the morning previously.

The glass tube, scale, and verniers having been securely placed on the board and perfectly upright, the gas-fitter proceeded to connect, by soldering, the remainder of the compo tube *above* the glass tube C, which was continued upwards till it entered nearly at the bottom into a round vessel K, made of zinc, 4 inches in diameter and 18 inches high. Inside the vessel the tube coils round in a spiral, like the worm of a still. This vessel and spiral are not necessary to the action of the barometer; but as the spiral is in the part of the tube in which is the vacuum-chamber, it gives the opportunity of artificially cooling with ice or snow the included aqueous vapour, and thus determining by actual experiment the amount of correction required.

If the experiment of cooling the included vapour to 32° be tried in summer, when the external temperature is 70° or 80°, the sudden cooling causes so great an evaporation from the surface of the water, and condensation in the upper part of the barometer, that a real rain-shower is produced, the condensed water running down the glass tube in innumerable pellucid drops in the most beautiful manner, thus perfectly imitating the condensation of invisible watery vapour in the higher regions of the atmosphere. When the compo tube leaves the zinc vessel, it is led up perpendicular to the Lambert tap L. Above the tap L the tube still rises perpendicular, when it suddenly bends down, leaving the end open at M.

I now describe the part of the barometer *below* the glass tube.

The compo tube being soldered on, was carried down to the cistern, not necessarily perpendicular; for instance, the tube may descend at an angle of 30° or 40°, and may be led in any convenient direction. The entire instrument erected by me is in the house, to escape a freezing temperature. At the lowest bend of the compo tube is a short upright tube, having at the end a Lambert tap N, to which is soldered a male screw of a ⅜th-inch gas union-joint O, the use of which will be understood further on. The compo tube now begins to ascend; and at the top of the bend is another Lambert tap P. Beyond this the compo tube bends down and reaches nearly to the bottom of the cistern, which is a one-gallon white-glass narrow-mouth upright bottle R. The bottle rests upon a stand S, which moves up and down by means of a set screw T, acting through a stout shelf U U; and the bottle is kept steady by means of the two uprights W, W, upon one of which is fixed the zero-point E.

I shall now describe the method of filling the barometer, which was as follows.

Four gallons of water were carefully distilled, and being put into *a perfectly clean and new* tin oil-can with a narrow mouth, the water was boiled for one hour over a bright fire, the object being to drive out the air. While still boiling, two quarts of olive oil were poured in. This slightly increased the pressure in the water underneath, causing the last remains of the air to rise with the steam in jets or spirts through the stratum of oil. The instant ebullition was stopped, the oil closed over the boiled water, and it became hermetically sealed from the atmosphere. The contents of the tin can were now cooled, and the can X was placed above the top of the water-barometer. A piece of $\frac{3}{8}$th-inch gutta-percha tube Y Y, sufficiently long to reach from the can X above to below the very bottom of the barometer, was procured, and one end of the tube was put into the mouth of the can X, the end passing through the supernatant stratum of oil down to the bottom of the water underneath. At the other end of the gutta-percha pipe Y is a $\frac{3}{8}$th-inch tap, terminating with a $\frac{3}{8}$th-inch female screw union-joint Z. The gutta-percha pipe being in position, and hanging down as seen in the drawing, became a siphon; and the air being sucked out, the water at once came over, and was stopped from running away by turning the small tap Z. The female union-screw at Z being tightly screwed on to the male screw-joint O, the water was ready to enter the barometer.

The first thing to be done was to displace the air in the bend of the tube, reaching from the tap N at the bottom, to the extreme end of the compo tube in the cistern R. This was done in the following manner:—The cistern or bottle was taken clean away and filled quite full to the very brim with best olive oil; the three Lambert taps being all open, and the bottom end of the "compo" tube hanging down, the small gas-tap Z was opened; the water then began to ascend both legs of the barometer, and when it reached the tap P, it passed over and ran out of the end of the tube which was hanging down. At that instant the stream was stopped with the thumb, and, the tap Z being turned off, the bottle full of oil was brought to the thumb which stopped the end of the compo tube and kept-in the water. The thumb supporting the tube was now put into the oil, and the end of the tube slipped down to the bottom of the oil. The bottle was then put into its place on the stand S, and the surplus oil being siphoned out, there remained in the cistern R about 3 inches in depth of olive oil, the compo pipe dipping into it *nearly* to the bottom.

The next thing was to fill the longer part of the barometer, which was accomplished as follows:—The tap P being closed and the small tap Z opened, the water rapidly rose in the barometer; when the water had reached the opening M at the top, it was allowed to run a minute or two to carry any traces of air away which might have lingered in the tube. Tap L at the top and tap N at the bottom being then securely closed, tap P was opened, and the column of water began to descend and to accumulate in the cistern R *under* the stratum of olive oil. As the column fell it was narrowly watched in the glass tube, but not a bubble of gaseous matter was observed. On examining the cistern R, it was found that the oil did not quite reach the zero-point E, more oil therefore was poured in till the zero-point E and the *level* of the oil were coincident. The graduated scale was now looked at, and it showed that the column of water was 400 inches high, the mercurial barometer being 30·4 inches, and the temperature 67°.

In order to test if gaseous matter would accumulate in the vacuum-chamber, the gutta-percha siphon was allowed to remain in its place for some weeks, and four different times tap P was closed, tap N opened, with tap Z, thus filling the barometer up to tap L at top, which being opened allowed the water and gaseous matter, if there had been any, to flow out at M. On closing tap L and tap N and opening tap P, the column of water again fell; and after siphoning out the surplus water from *under the oil* in the cistern till the oil was level with the zero-point E, the column of water was found on the four different trials to be exactly the same height on the scale after each trial as before. It was therefore plain that no gaseous matter had accumulated above the water, and that, with the exception of the vapour of water, it was a perfect vacuum.

I will now mention one or two precautions which are required in order to ensure success. In the first place the water must be distilled—for this reason, amongst others, that if the water contains "earthy salines" or colouring-matter, it is certain, by the constant evaporation and precipitation in the working part of the glass tube, to crust it over so completely, that in a few months the water becomes invisible; pure distilled water is therefore indispensable. Then, if the slightest leak in the barometer exists, it will infallibly bring the instrument to grief. In order, therefore, to be sure that the barometer was sound (before the water deprived of air was put in), I closed tap L at top and tap P; then, connecting the gutta-percha tube with the "street waterworks" pressure, I allowed it to enter the barometer till the included air was contracted to one-fourth of its length, having a pressure of water under it of between 40 and 50 lbs. to the inch.

The barometer stood this internal pressure for ten hours

without the air being forced out. I therefore concluded that if the barometer would stand this great pressure *inside*, it would stand 14 lbs. to the inch pressure on the outside, and without hesitation I filled it with the prepared water.

As the instrument is made by a gas-fitter, it would be easy to put the whole of it together, Lambert taps included, and to *prove it* with some powerful water-pressure *before* the instrument is taken to the place where it is to be erected. Also the water deprived of air and covered with the stratum of olive oil in the tin can could be sent, if necessary, 100 miles away without the possibility of any air getting into it. If a gutta-percha pipe is not to be had to fill the barometer, a piece of compo tube will answer every purpose, which, when done with, is none the worse for gas-fitting purposes.

I shall conclude with some account of the action of the water-barometer. In the Philosophical Transactions for 1832 is a description by Mr. Daniell of a water-barometer which he erected at the "Royal Society's Rooms," at Somerset House, which was in action for two years, but afterwards got out of order. In describing the action, Mr. Daniell states that "the water appears to be in perpetual motion, resembling the slow action of respiration."

I can fully corroborate Mr. Daniell in this particular, and from careful and continued observation am able to state that the times of the oscillations are about every four minutes and twenty seconds. It is requisite to watch the oscillations with a magnifier, as they vary from the twentieth to the thirtieth part of an inch, which distance can be well observed when it is slightly magnified. But the most surprising oscillations in the water-barometer are during a thunder-storm accompanied with great falls of hail and heavy rain-drops. I have given a chart of five minutes' readings for one hour and five minutes during a heavy thunder-storm from the north-east, which passed over Birmingham July 20, 1859. The upper curved line shows the water-oscillations, and the lower curved line shows the oscillations in the mercurial barometer. The temperature is recorded at the foot. It will be observed that while the water-column rose and fell in a most surprising manner, the mercurial column showed hardly any motion, which was of a laggard character.

At 4.20 P.M. the storm reached its climax, the heavens grew darker overhead, and the water rapidly descended, causing a most impressive feeling on the mind, when suddenly came a terrific blaze of lightning instantly followed by the "thunder cannonade" (if I may so call it); then down came the hail and heavy rain, and as the sky began to brighten the water commenced to rise, and in the next five minutes it had risen more than four-tenths of an inch.

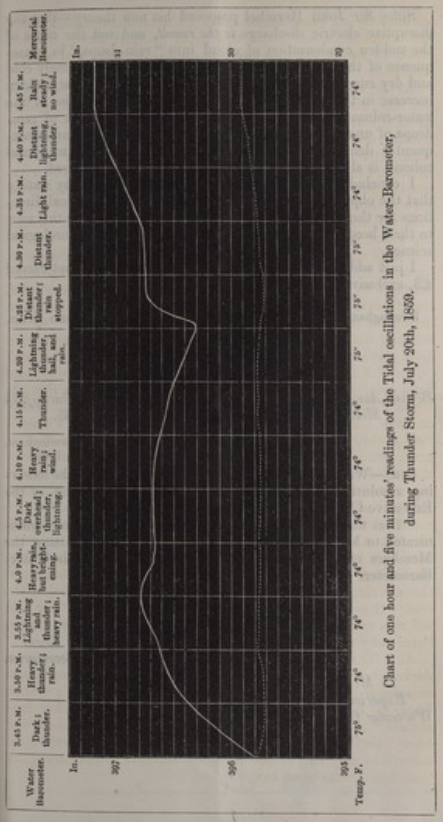


Chart of one hour and five minutes' readings of the Tidal oscillations in the Water-Barometer, during Thunder Storm, July 20th, 1859.

Since Sir John Herschel proposed his new theory—that the disruptive electric discharge *is the result*, and not the cause of the sudden condensation of cloud into "rain-drops," in consequence of the cloud coming in contact with an extremely cold and dry current of air—it has occurred to me that the sudden increase in the density of the air, as shown by the rise of the water-column, *may* be due to the *sudden* precipitation of rain-drops of unusual size, leaving the atmosphere drier and consequently denser; it being well established that the mercurial column is always high when the air is dry, and *vice versâ*.

I conclude this account of the water-barometer by stating that the object with which it is written is to give practical directions for the construction of these noble instruments with a view to their becoming common for the furtherance of meteorological science.

I just add that the total cost of the materials need not exceed £3, exclusive of gas-fitter's time.

I am, &c.,

Birmingham, October 14, 1865. ALFRED BIRD.

APPENDIX.

British Association for the Advancement of Science. Thirty-fifth Meeting, held at Birmingham, September 6, 1865.

52 New Street, Birmingham,
October 25, 1865.

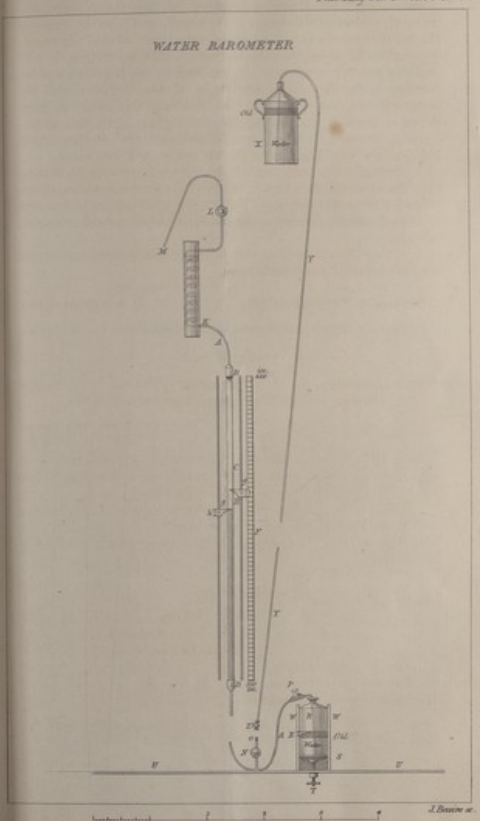
SIR,—We have the pleasure of informing you that the following resolution was unanimously passed at a Meeting of the Executive Committee, held on the 11th instant:—

"That the best thanks of the Executive Committee be communicated to Mr. Alfred Bird for his kindness in admitting the Members of the Association to the inspection of his Water-Barometer.

We are,
Yours faithfully,

G. D. BOYLE,
J. H. CHAMBERLAIN,
W. MATHEWS, Jun., } *Local Secretaries.*

To Mr. Alfred Bird,
Experimental Chemist,
Worcester Court, Birmingham.



From the PHILOSOPHICAL MAGAZINE for May 1867.

ON THE FUNCTION OF THE BLOOD IN MUSCULAR WORK.

BY

C. W. HEATON, F.C.S.,

LECTURER ON CHEMISTRY TO CHARING CROSS HOSPITAL MEDICAL SCHOOL.

MOST of the recent writers on the origin and nature of muscular power seem to have assumed that the oxidation from which it is derived is effected in the tissue itself, outside the walls of the capillaries. Those who, with Liebig, Voit, Ranke, and Playfair, derive the whole of the power from the oxidation of the tissue, find this assumption a necessity; but it appears to have been adopted also by Fick and Wislicenus, who follow Traube* in assigning the office to the fats and so-called carbohydrates, and by Donders, who attributes it to both classes of compounds.

Mayer, however, in his now celebrated treatise†, adopted a different view, and argued with extreme ability that all oxidation took place in the blood. Since his time this theory has received some occasional isolated support; but upon the whole it appears to have been neglected. This is the more curious, since its truth would not only destroy the hypothesis of Liebig, but also the opposite and not less extreme one of Traube. For if force ge-

* Virchow's *Archiv*, vol. xxi. p. 386 (1861).

† *Die organische Bewegung in ihrem Zusammenhange mit dem Stoffwechsel*, 1845.

nerated inside a capillary is capable, under the influence of the nerves, of producing muscular contraction outside it, it is obviously impossible to assign the origin of that force to either nitrogenous or non-nitrogenous compounds exclusively. Fick and Wislicenus have shown, as Donders had before, that the oxidation of the latter class of compounds contributes something, perhaps the greater part, to muscular work; but, on the other hand, it cannot be doubted, after Savory's experiments on rats and Voit's upon a dog, that muscular work may be performed as usual in an animal body, even when non-nitrogenous articles are entirely excluded from the food.

The beautiful experiments of Stokes* have illustrated very remarkably the mode in which oxidation is effected in the blood. He showed that the colouring-matter of the corpuscles, to which he applied the name of cruorine, was capable of acting as a carrier of free oxygen between the air and the oxidizable materials of the blood. He illustrated this function not only by the action of reducing agents on a solution of the corpuscles, but also by the more striking experiment of allowing the blood-solution to reduce itself by remaining for a few days in a tube out of contact with air. The cruorine was again oxidized instantaneously by agitation with air. This last experiment proves that the corpuscles have the faculty of oxidizing nitrogenous materials, either their own substance or else some portion of the serum with which they are in contact. Hoppe-Seyler has since found† that, in a rabbit killed by drowning, the blood exhibits the spectrum of reduced cruorine. That the oxygen is held in combination in the corpuscle by the weak force termed by Frankland "molecular combination," is evident from the well-known fact that carbonic oxide displaces from it its own volume of oxygen.

Now, if the oxidation of muscle is effected in the tissue itself, it is clearly necessary to suppose either that the oxygen, upon the stimulus of the motor nerves, leaves its combination in the corpuscle, traverses the walls of the capillary in company with the outgoing stream of nutrient fluid, and only enters into new combinations when it has passed to some comparatively distant muscle-fibre, or else that the corpuscle itself liquefies and passes out bodily through the thin membrane with its loosely combined oxygen. Both suppositions seem to me very improbable; for, as Stokes's experiment proves that the absorbed oxygen of the corpuscle is capable, without any nerve-influence, of entering into direct combination with the materials of the blood itself, it is difficult to understand why such combination should be deferred until the oxygen has traversed the walls of the capillary.

* Proc. Roy. Soc. vol. xiii. p. 355.

† *Zeitschrift für Chem.* New Series, vol. i. p. 214.

Moreover, as muscle-fibre is now known to be at any rate not the only substance oxidized to produce muscular work, it is plain that much of that muscular work must, upon the current theory, be produced by the oxidation *outside* the capillary of the very same substances, fat &c., which are present abundantly *inside* it. Why oxygen should reject fat inside the capillary and oxidize it outside it is hard to imagine.

But evidence of a more direct kind is, I think, accessible to us. The tissues are undoubtedly nourished by a stream of fluid which exudes from the walls of the capillaries in virtue of the pressure to which the blood is subject. As the tissues disintegrate they liquefy and are carried, together with the excess of the nutritive fluid, back to the blood by means of the lymphatics, which take their origin in the intervascular spaces of the tissue. Hence Mayer suggested that the lymph was a measure of the amount of fluid exuded from the walls of the capillaries. Taking the quantity of lymph from Majendie's calculation, he inferred that not 1 per cent. of the blood left the blood-vessels in the course of the circulation, and consequently, as all the blood required renewal on its return to the heart, that 99 per cent. of the total oxidation of the body was effected in the blood-vessels. In this form, however, the proof is not quite complete. It may be argued that a large proportion of oxygen leaves the blood-vessels in the exudate, and that, small as is the total quantity of the latter, it may yet contain enough oxygen to do the work of the muscles.

I have therefore made a calculation of the quantity of oxygen which can possibly be supposed to pass out of the blood. I purposely exaggerate every figure employed, in order if possible to avoid cavil.

The first point is to ascertain the extreme quantity of fluid exuded in twenty-four hours. Bidder and Schmidt estimate the lymph at 22 lb. I will take it at 30 lb. A large proportion of this arises of course from glands and other organs which do no muscular work; but this I neglect. It may be suggested that some part of the fluid exuded may return direct to the capillaries without passing through the lymphatic system. No doubt this is the case; but the quantity so returned is probably small, as the pressure in the vessels would naturally tend to prevent it. The pressure, indeed, probably acts in forcing the fluid onwards into the lymphatics. Nevertheless, to avoid question, I will assume that the quantity returned in this way is twice as great as the lymph, and I thus get 90 lb., or about 40 litres, as the daily amount of exudate; and I think every one will admit that this is an extreme overstatement.

Any oxygen which passes out into the tissue must obviously

pass in solution in this 40 litres; and the next point is to ascertain the quantity of oxygen which it can possibly be supposed to carry with it. Lymph resembles diluted liquor sanguinis in composition, and is destitute of colour. The exudate is therefore in all probability derived mainly from the liquor sanguinis, which, as Berzelius showed, will hardly dissolve more oxygen than water. Moreover, its dilution proves that, as might have been anticipated from the colloidal character of blood, a considerable part of the exudate actually consists of water. But, to put the case in the strongest possible light, I will assume that the whole of the exudate consists of liquefied corpuscles—of scarlet cruorine, in fact, charged to its utmost with oxygen. Again exaggerating, I assume that the corpuscles of arterial blood contain 40 per cent. by volume of oxygen. This gives as the quantity of oxygen in the 40 litres of exudate 16 litres, or 22·88 grammes. Is this sufficient to do the muscular work actually accomplished in the twenty-four hours? The following is an extremely low estimate of the daily work of the muscles:—

	Metrekilogrammes.
Heart	70,000
Lungs	10,000
Voluntary muscles . .	20,000
	100,000

To do even this small amount of work, double the quantity, or 200,000 metrekilogrammes of force, must be developed (Heidenhain). Now 22·88 grammes of oxygen would oxidize—

7·89 grms. of fat, taken as having average composition of oleine, margarine, and stearine (Lawes and Gilbert),

or 15·39 grms. of muscle, taken as equal in composition to albumen.

Multiplying these quantities by the force-values obtained by Frankland*, we obtain these figures:—

		Metrekilogrammes.
Fat	7·89 × 3841 . .	= 30,305
Muscle	15·39 × 1848 . .	= 28,440

So that, even upon this extravagant calculation, we see that whether it oxidized fat or muscle, the oxygen exuded could not account for one-sixth of the work done by the muscles. To give even the 200,000 metrekilogrammes of force there must be a daily exudate of 264 litres, or more than a quarter of a ton of arterial corpuscles!

I think it is therefore certain that all, or nearly all, the force of the body is generated in the blood, and that Mayer was perfectly right in saying that "the muscle produces mechanical effect at the expense of the chemical action expended in its capillary vessels." Hence it is natural to inquire what modification this view compels us to make in our ideas of muscular disintegration.

* Phil. Mag. September 1866.

In the first place, it forces us to admit that this disintegration is a simple decomposition, and not an immediate oxidation. When a muscle suffers disintegration, either by natural change or during muscular work, two classes of compounds are known to be produced. The members of one class are ternary and contain the residue of water, while those of the other are quaternary and contain directly or indirectly the residue of ammonia. To the former class belong the fatty acids, lactic acid, sugar, &c., and to the latter such bodies as leucin, creatin, creatinin, uric acid, and urea. The greater portion of these products of decomposition are probably carried to the blood by the lymphatics; and some of them, notably sugar, leucin, and urea, have been discovered in the lymph. The oxidation in the blood of such of these compounds as are capable of it contributes to the heat, and probably to the work also of the body. Professor Haughton, in his well-known papers on Diabetes mellitus*, while he assumes that the normal disintegration of tissue is an oxidation, suggests that in the diseased state a large portion of the tissue is not oxidized, but is simply decomposed into urea and sugar. Mayer's view compels us to believe that this, or something like this, is the normal process, and consequently that the phenomena of diabetes, as far as they are independent of the nature of the food, must be due either to increased disintegration or to diminished oxidation, or possibly to the conjunction of both causes. He found that increased excretion of urea went hand in hand with the presence of sugar in the urine; but as the food of the patients was increased from two- to four-fold, the observation does not prove much. The great bulk of the nitrogen of the food *must* be excreted as urea.

I will not speculate on the mode in which force developed in the blood is capable of producing contraction in the tissue. The process is subject to the control of the nerves, and is probably connected with the production of electricity; but one conclusion seems so probable that I cannot help suggesting it. It has long been known that muscular contraction is invariably attended with increased muscle-metamorphosis. Liebig, Helmholtz, Du Bois Reymond, Ranke, and others have left no doubt upon this point; and it may even be considered to be proved that increased work is attended with a slight though irregular increase in the excretion of nitrogen; for though in Fick and Wislice-

* Dublin Quarterly Journal of Medical Science, vols. xxxi. xxxii. xxxv.

nus's experiment, as well as in many previous ones, this result was not observed, its absence has been shown to be due to the shortness of the time during which the observation was made, and in the recent careful experiments of Dr. Parkes*, in which this source of error was eliminated, the increase was clearly shown.

What, then, is the cause of this increase? It is obviously absurd to attribute it to mere mechanical friction of the muscle-fibres, to ordinary wear and tear; and it therefore seems natural to ascribe it to the excess of force which remains after the performance of the work. That an excess of force is always developed is certain; and though much of it may afterwards assume the form of heat, it seems not improbable that some part may be spent in producing chemical decomposition, and so be once more stored up as potential energy. It appears indeed possible that all normal muscular disintegration, inasmuch as it is subject to the influence of the nerves and attended with electrical currents, may be effected in this way. If this view be accepted, muscular disintegration, so far from being the cause of muscular work, must rather be regarded as an effect contingent upon it.

Ranke's beautiful experiments upon the effect of the products of muscle-metamorphosis in checking muscular contraction by increasing the conductivity of the tissue, are in perfect accordance with Mayer's theory.

* Proc. Roy. Soc. vol. xv. p. 339.

Prof. E. A. Parkes
M.D., F.R.S.
With the Author's
kind regards.

ON A CASE

OF

CONCUSSION-LESION,

WITH

EXTENSIVE SECONDARY DEGENERATIONS OF THE SPINAL CORD,

FOLLOWED BY GENERAL MUSCULAR ATROPHY.

BY

H. CHARLTON BASTIAN, M.A., M.D. Lond.,

LECTURER ON PATHOLOGICAL ANATOMY, AND ASSISTANT-PHYSICIAN TO ST. MARY'S HOSPITAL.

COMMUNICATED BY

H. HAYNES WALTON, F.R.C.S.

[*From Volume L of the 'Medico-Chirurgical Transactions,' published by the Royal Medical and Chirurgical Society of London.*]

LONDON:

PRINTED BY

J. E. ADLARD, BARTHOLOMEW CLOSE.

1867.

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H. HAYNES WALTON, F.R.C.S.

Received June 11th.—Read June 25th, 1867.

The following case presents many distinct points of interest. In the first place, because from a concussion not more severe than might occasionally be experienced in a Railway accident, the most unmistakeable, and even extensive, lesions of the spinal cord were produced at the time, and recognised after the patient's death. Then, though these primary and other extensive secondary lesions of the spinal cord were recognisable with the greatest ease after the organ had been immersed for a period in chromic acid, yet at the time of the autopsy itself, when the organ was in the fresh condition, no morbid appearances were detected even by careful scrutiny, and that for reasons which I shall hereafter be able fully to explain.

Much interest also attaches to the distribution of the areas of secondary degeneration, on account of the bearing which this has upon the physiological anatomy of the spinal cord; and also to the histological nature of the changes produced, since these serve not a little to elucidate the real nature of cerebral or spinal *ramollissement*. And lastly, the gradual supervention of a general muscular atrophy in conjunction with the wasting of a portion at least of the great sympathetic system, lends an additional interest to the consideration of this important case.

The man on whose spinal cord these observations have been made was a patient of my colleague Mr. Haynes Walton, and I am much indebted to him for his kindness in placing the organ entirely at my disposal for examination. It is much to be regretted that we are unable to give more perfect and accurate notes of the case, and that the clinical history is very imperfect. What I have been able to ascertain concerning the patient is derived from some early notes on the case by Mr. Tatham, late house-surgeon to St. Mary's Hospital, supplemented by other particulars communicated by Mr. Haynes Walton himself.

History.—Jeremiah C—, æt. 26, admitted into the accident ward of St. Mary's Hospital, July 7th, 1866; about a week ago was sleeping on the top of an unfinished hay-rick, twenty-five feet in height, and whilst asleep rolled off, falling on his back. He found himself, at once, unable to move, and was conveyed to the Barnet Union, where he remained, till, at his own request, he was removed to this hospital.

State on admission.—He lies on his back; his legs are motionless, but he retains sensation in them, although he is unable to state the exact number of fingers touching him at a time. Can raise his thighs a little when he makes a great effort; the toes are dropped and point helplessly downwards; toes twitch when soles of feet are tickled. The right arm is also partially paralysed; the wrist is dropped, he is unable to move the fingers, and he can only just raise the

limb from the bed. The bladder is paralysed, and the urine ammoniacal. The bowels were moved soon after the accident, but have not been opened since. The breathing is purely diaphragmatic, the intercostal spaces falling in at each inspiration: number of respirations per minute, 32. Has a little bronchitis, and has a great difficulty in coughing up the phlegm. Pulse 88, soft. Temperature in axilla 97° Fahr. Already there is a large bed-sore over sacrum four or five inches in diameter. He complains of soreness and stiffness in the neck, and of slight pain in the neighbourhood of the first and second dorsal vertebræ; but no fracture or displacement can be detected there. (Mr. Haynes Walton writes, "he was raised in bed for me to examine his back, but there was no mark, nor any tenderness except on the upper part of the dorsal region; but this was really very slight, considerable pressure and percussion being scarcely complained of.") Ordered:—Ol. Ricini ʒss, statim (by means of which bowels were moved—he himself being quite conscious of the fact, though unable to exercise any voluntary control); full diet, with 4 oz. of port; to be placed on a water-pillow, and the bed-sore to be dressed with glycerine.

July 8th.—Has not slept well, being much troubled with startings in the legs (the first time since the accident). In other respects, in the same state as when admitted.

9th to 13th.—The startings are very troublesome—does not sleep much.

14th.—Startings chiefly confined to the right leg; is able to move the toes of the left foot a little.

17th.—A small slough has come away from the sore, granulations healthy.

21st.—Is gradually gaining a little power in the extensors of the right forearm; can move the fingers a little. The urine now dribbles away from him, even when there are but a few ounces in the bladder; complains of pain in the lower part of the abdomen and along the urethra: there has been a slight purulent discharge from the urethra for the last day or two.

24th.—Seems rather low, the voice is weak, and his speech

drawling. States that his voice is completely changed since the accident. Takes food pretty well; has 6 oz. of port wine in addition to brandy.

August 1st.—Complains of pain in right leg; nothing can be seen to account for it. There is no tenderness at any part of the spine, even when heavy pressure is made.

5th.—Hips and shoulders are a little rubbed; sore on back healthy. Is gaining a little more power over the right hand. Seems to be improving in general health, and is much more cheerful than he was. Is now propped up in bed at his own request.

18th.—Is gaining more power in his left leg; often complains that his legs pain him. Sore over sacrum much healthier.

Through a change of house-surgeons the notes unfortunately cease at this stage. Mr. Haynes Walton tells me, however, that though in the early part of August the patient could move his right arm a little, yet this very soon began to undergo a rigid contraction, which steadily increased till the wrist almost touched the shoulder. Up to this time, also, he was only ordinarily thin, but he soon began to waste perceptibly day by day, in spite of a nourishing diet with plenty of stimulants. For the last two or three months, also, he was often sick and vomited his food. The bronchial tubes became loaded with thick mucus, and at times he seemed likely to suffocate, because he had such difficulty in expectorating. For a long time he passed his urine involuntarily, but afterwards he could retain it, though he suffered great pain during its passage, and latterly blood came away with it. Bowels were never moved without the aid of castor oil. Throughout, sensation seemed to be scarcely, if at all, impaired in the paralysed or other parts of the body. From the first to the last he was on a water bed, and everything was done to prevent other bed-sores from forming, but in vain. His position was continually changed and adjusted, until he became too weak to bear the fatigue which this induced. His mind was clear till the end. He was literally dying for weeks. His appetite got less and less, whilst his

desire for stimulants increased. During the last seven weeks he took daily 2 oz. of brandy, 6 oz. of port, and two bottles of stout with two pounds of beef jelly. He died on December 31st, 1865.

Autopsy thirty-six hours after death.—Body emaciated to a most extreme degree; large sore over sacrum; no scar or appearance of former wound higher up in back; no irregularity of vertebral spines; thighs and knees rigidly flexed; right elbow rigidly flexed.

Brain presented no abnormal appearance. After removing *vertebral* arches, these appeared perfectly natural—there was no displacement or irregularity in any part. The *spinal cord* was in no way compressed. On cutting open dura mater, the vessels on surface of cord were seen to be large and turgid with blood. No wasting or alteration of shape was observed in any part, and on section in the upper cervical region, through middle of brachial enlargement, and in various parts of dorsal and lumbar regions, no morbid change was detected; the internal vessels were also somewhat turgid with blood, but the consistence of the organ was good, and the sections to the naked eye presented a healthy appearance. *Pericardium* dry. *Heart* healthy, small, weight 7 oz.; right cavities containing semifluid blood. No fat on surface. Both *pleuræ* dry and free from serum. *Left lung*, old adhesions about apex; deposits of tubercle and superficial puckering also in this situation; a few small granular patches of tubercle in other parts of lung; weight 14 oz. *Right lung* much more firmly adherent and more solidified about apex; also containing tubercle scattered through other parts; weight 19 oz. *Peritoneum* dry. Areolar tissue around organs also quite dry and tough, so as to cause some difficulty in removal of kidneys. *Liver* large; very pale; moulded to shape of abdomen; tissue more resistant than is ordinarily the case with fatty liver; weight 50 oz. *Spleen* healthy, somewhat small; weight 5 oz. *Kidneys*, both organs in much the same condition; large, very pale, and considerably congested. The congestion was well seen on surface, when capsules, which could be stripped off freely,

were removed. In each organ also there were two or three small calculi of a pale colour, and about the size of peas, situated together with purulent-looking fluid in some of the calices; weight of right 8 oz., and of left 7 oz. *Intestines* (not opened) appeared healthy.

The fact that no naked-eye appearances of disease could be detected in the cord at the post-mortem examination, seeing that extensive deviations from the normal structure were subsequently found to exist, is a subject of much interest in connection with the numerous instances in which pathological changes have been looked for in this organ, and have not been recognised. I may add that Dr. Sieveking and Mr. Haynes Walton were both present at the time of the post-mortem examination, and were also unable to detect anything abnormal in the appearance of the organ, when sections were made in various parts. I call attention to this fact particularly, because it is a very important one to be borne in mind, and because it is the rule rather than the exception in cases of secondary degeneration of the spinal cord. Dr. Bouchard, the author of a most valuable memoir on this subject, writes,[1] "Je dois dire dès l'abord que ces dégénérations secondaires de la moelle échappant le plus souvent à un examen même attentif." As far as the present case is concerned it is easy enough to comprehend why the extensive pathological changes were not recognised by a naked-eye examination of the cord in its fresh state. The diseased tracts did not differ in colour from the healthy nerve-substance, neither did their consistence differ from that of adjacent parts; and, except in one limited portion of the cervical region of the cord (through which particular part no section happened to have been made at the time of the autopsy), a most careful subsequent examination has revealed no loss of symmetry in any part of this organ. With the absence of the ordinary naked-eye characters of disease—with no deviation from the normal consistence, colour, or symmetry of the organ—it is not so much a subject of wonder that pathological changes, complying with these conditions, should

[1] 'Archiv. Générales de Médecine,' 1866, p. 273.

escape detection, even after a careful examination. The occurrence of cases of this kind should, however, strongly impress upon us the necessity of not passing a too hasty verdict upon organs, in which we have failed at an ordinary post-mortem examination in recognising well-marked structural changes, such as might have been expected to have been present, considering the nature of the symptoms presented during life. In this case, I examined, almost immediately after the autopsy, portions of the nervous tissue taken from various parts of the cord, with the aid of the microscope, and at once found that all parts of the organ—from the lumbar enlargement up to the medulla oblongata—contained variable quantities of well-developed granulation corpuscles, or "compound inflammatory globules," as they were unfortunately named by Gluge. Having thus satisfied myself as to the existence of morbid changes in the organ, I cut segments of it off and put them aside to harden in a solution of chromic acid. After immersion for a certain time in this fluid, the areas of degeneration became most easily recognisable by the naked eye, on the surface of freshly-cut segments of the cord, owing to the fact that the diseased tissue, though hardened in the same way as other parts, had not become stained by the chromic acid. Thus the diseased tracts preserved their original dead white colour, whilst the adjacent healthy nerve-tissue had been stained to the usual extent, and presented a yellowish-brown hue. By this difference in colour alone, and even by a naked-eye examination, the distribution and extent of the various areas of degeneration, which I am about to describe, could be easily detected throughout the whole extent of the cord which was thus preserved. It is much to be regretted that I did not preserve the whole organ, since there is every reason to believe that some important lesions must have been situated in a part of the cord occupying the mid-cervical region, which was not kept. Not realising the full importance of preserving the whole of the organ at the time, I put aside, for subsequent examination, only the medulla oblongata attached to about one half of the upper portion of the spinal cord, the brachial enlargement, portions

from the dorsal region, and the whole of the lumbar enlargement, and it was only when too late to rectify the mistake that I discovered how important it would have been to have retained the whole of the cervical portion of the cord. Although the absence of certain portions of this is most unfortunate, still, in the portions preserved, sufficient primary lesions and secondary degenerations have been detected to make this case one of extreme interest.

Before describing the situations of the lesions, and the extensive secondary degenerations resulting from them, it will be well, I think, for me to give a few explanations as to the cause and nature of the latter, since our knowledge concerning this change may still be considered a recent acquisition, and one, therefore, not perfectly familiar to all readers.

It is to Dr. Augustus Waller[1] more especially that we are indebted for our knowledge of the changes which take place in the distal portions of divided nerves; also for important information concerning the different effects produced when the anterior and the posterior roots respectively of the spinal nerves are cut; as well as for the practical application of this knowledge, whereby we are provided with an accurate method of investigating the distribution of nerve-fibres, even in the central nervous system itself. These lines of investigation have been followed out and extended principally by Schiff, and by MM. Phillipeaux and Vulpian.[2] The order of the changes taking place in the fibres of the distal extremity of a cut nerve are these: about the fifth day after section, the nerve-fibres may be seen, with the aid of the microscope, to present the first visible deviations from their normal condition; their contents become slightly cloudy, and the borders of the fibres are less sharply defined—deviations so slight that they can only be recognised by comparison with

[1] 'Nouvelle Méthode Anatomique pour l'investigation du Système Nerveux' (Lettre à 'Acad. des Sciences du 23 Nov., 1851). Bonn, 1852.

[2] "Sur la Régénérat. des nerfs separés des centres nerveux" (Mem. de la Soc. de Biolog., 1859, p. 343). 'La Physiolog. Génér. et Comp. du Syst. Nerv.' Paris, 1866, p. 236.

other healthy fibres. By the eighth day, however, changes are much more easily recognisable; the medullary sheath has become obviously opaque, the double contour of the fibre on each side has become irregular and interrupted in places, owing to a kind of strangulation of the medullary matter; whilst by the tenth day, or even sooner, this strangulation has gone on to actual segmentation of the white substance into portions of various sizes. During the succeeding days the segmentation still progresses; the original fragments of myeline breaking up into successively smaller and smaller portions, which finally assume a more or less spherical form and fatty aspect. These are contained within the sheath of each nerve-fibre, and completely conceal the axis cylinder. After a month or six weeks the segmentation has become more complete, the medullary matter being reduced to small globules; whilst after two or three months only granulations so fine can be seen within the nerve-fibre, that they resemble "une poussière qui remplirait la gaine conjonctive." At last these granulations disappear, and we arrive at the ultimate change: the sheath of Schwan collapses, and folds upon itself and upon the axis cylinder so completely, that the nerve-fibres are scarcely distinguishable as such. Having become grey also from the disappearance of the white matter, a bundle of such altered nerve-fibres under the microscope can scarcely, at first sight, be discriminated from a bundle of fibrous tissue. Dr. Waller believed that the axis cylinder disappeared altogether, and that in cases where a restoration of function took place in the cut nerve, this was due to an actual new production of nerve-fibres amongst the débris of the old. The observations of Schiff, however, and of MM. Phillipeaux and Vulpian, show that in this respect Waller was wrong. Each of these observers had recognised the existence of the axis cylinder, after an interval of more than six months, and they maintain that when the functions of a nerve so altered are restored, this is brought about not by the generation of nerve-fibres, but by the re-formation of the myeline within the shrivelled sheaths, and around the comparatively unaltered axis cylinders of the original nerve-fibres. Thus

much concerning the actual changes in the individual fibres; but Phillipeaux and Vulpian also state that in the experiments which they made upon dogs, they found the atrophied fibres of cut nerves much more difficult to separate from one another, by a teazing process, than were the healthy fibres of an uninjured nerve. This they attributed to the fact that the fine connective tissue, which normally exists in small quantity between the fasciculi of a nerve, had become hypertrophied, and consequently more tenacious.

When Waller (after having ascertained the various changes which take place in the distal portions of cut nerves) turned his attention to the effects of section of the anterior and posterior roots of the spinal nerves, he soon made known important results as to the *direction* which this degeneration takes in sensory and motor nerves respectively; and he came to the conclusion that such atrophic changes were due to the severance of the connection between portions of the nerve-fibres and their ganglionic attachment—to the interruption, in short, of some controlling nutritive power which is normally exercised over the whole length of each nerve-fibre by the nerve-cell at one of its extremities, and from which it proceeds. This influence is usually exercised in the direction of the physiological action of the fibre; thus, when the anterior roots of the spinal nerves were cut, Waller found that the fibres in the proximal portion of the cut roots retained their normal structure, whilst those in the distal portions (from the cut extremities to their peripheral distributions) underwent the changes above described. When the posterior or sensory roots of the spinal nerves were cut, on the other hand, the distal extremities in connection with the ganglia of the posterior roots preserved their healthy structure, whilst the fibres of the proximal portions underwent the atrophic change, and by this means could be traced ascending for various distances in the posterior columns of the cord, and finally losing themselves in the grey matter. From this, Waller concluded that the nerve-cells presiding over the nutrition of the motor nerve-fibres were situated in the grey matter of the cord, whilst those for the nerves of sensation

were situated in the ganglia of the posterior roots—thus showing one definite function at least for these bodies.

Other observations have tended to show that the course of secondary degenerations generally in the antero-lateral columns of the cord may be said to be downwards, whilst in the posterior columns it is just the reverse. The exception to this rule will be stated hereafter. After what has been said, it would be needless to insist upon the important aid which degenerations of this kind afford, in enabling us to determine some of the most difficult problems in connection with the anatomy of the nervous system, by facilitating our tracing the distribution of nerve-fibres through plexuses or complex organs, such as the spinal cord. This method seems second to none for the accuracy of its results, and when used experimentally it has been named by Vulpian, in honour of its discoverer, the "Wallerian method" of investigation.

The above explanations as to the effects produced by sections of nerves, sufficiently explain the nature of secondary degenerations of nerve-tissue, since the process is perfectly similar in each case; and this enables me now to say a few words concerning the history of such degenerations. Cruveilhier was the first to discover descending secondary degenerations as a result of lesions of the brain.[1] These he recognised in the cerebral peduncles, in the pons, and in the medulla oblongata, though he did not succeed in tracing them into the cord. To Türck, of Vienna, is due the honour of having first called attention to these lesions in the spinal cord, in an important memoir[2] which was presented to the Academy of Sciences of that city in 1851, that is to say, in the same year that Waller made known the most important results of his experiments on the degeneration of cut nerves. Whilst, two years later,[3] Türck presented to the same academy another memoir in which he analysed thirteen cases of secondary

[1] 'Anatomie Pathologique,' livraison xxxii, p. 15.

[2] 'Compt. rend. de la sect. de Mathémat. et Sciences Nat. de l'Acad. des Sc. de Vienne,' Mars, 1851.

[3] 'Compt. rend. de l'Acad. des Sciences de Vienne,' t. xi, p. 93, Juin, 1853.

degeneration following cerebral lesions, and twelve others resulting from primary lesions of the spinal cord itself. Notwithstanding the important nature of these communications they appear to have attracted but slight attention, since such lesions are scarcely mentioned in Rokitansky's great work, and are entirely passed over by Lebert. Nearly at the same time that Türck made known the results of his researches, solitary cases were recorded by Schroeder Van der Kolk, and by MM. Charcot and Turner.[1] In 1859 M. Gubler wrote a memoir[2] on secondary degenerations of the brain, and since this time various instances of such changes in the brain and spinal cord have been recorded in the *Comptes rendus de la Société de Biologie* of Paris and in the *Bulletins de la Société Anatomique* of the same city, by MM. Charcot, Velpeau, Cornil, and Bouchard. Leyden[3] has also published a remarkable case of secondary degeneration of the spinal cord, as a result of compression from Pott's curvature of the spine; and lastly, Bouchard has recently published an admirable memoir[4] on the whole subject, to which I have been much indebted, and in which he treats of secondary degenerations of the spinal cord, resulting severally from lesions of the brain, primary lesions of the cord itself, and lesions of the posterior roots of the spinal nerves. To this work I shall frequently refer. So far as I have been able to ascertain, the case which forms the subject of the present communication is the first that has been described in Great Britain or Ireland.

These secondary degenerations, which occupy a certain extent of the columns of the cord, either throughout the whole or a considerable length of the organ, develop themselves rapidly, and also simultaneously, in the different parts of the diseased tracts. This might have been imagined

[1] "Exemple d'Atrophie cérébrale avec Atrophie et déformation dans un moitié du Corps" ('Compt. rend. de la Soc. de Biolog.,' 1852, p. 19).

[2] 'Archiv. Gén. de Méd.,' t. ii, p. 31, 1859.

[3] 'Die graue Degenerat. des hintern Ruckenmarksstrenge,' Berlin, 1863.

[4] 'Archiv. Gén. de Med.,' 1865, and subsequently republished in a separate form.

from what has been already said concerning the changes taking place in cut nerves, and seeing that such degenerations involve a definite series of tissue changes, it will be easily understood that the microscopical characters, and even the naked-eye appearances, of the diseased tracts vary in different stages of the retrograde process. According to Bouchard, secondary degenerations consist of and include the following changes:—1. An atheromatous alteration of the capillaries, and the formation of granulation-corpuscles in the degenerating tissue; 2. The alteration and finally the disappearance of a more or less considerable number of nerve-fibres; 3. The formation of connective tissue which substitutes itself in the place of the atrophied nerve-fibres. It will be seen further on that I accept Bouchard's account of the first two kinds of changes only with certain qualifications. It will be recognised also that the last two changes are precisely those which take place in the distal extremity of a cut nerve, if my interpretation of the nature of the second change be accepted instead of that given by Bouchard. He speaks not only of the alteration, but also of the disappearance of the affected nerve-fibres, and says, "Je puis ajoûter qu'il ne m'a jamais été permis, de retrouver les cylindres d'axe dénudés dans les cas de dégénération secondaire, et aucune observateur n'a constaté cette persistence." To which I can only reply, that when portions of the secondarily degenerated tissue of a spinal cord have been treated with a solution of soda, tinted with carmine, thoroughly teazed with needles, and have then been finally mounted in glycerine, nothing is more easy than to demonstrate the axis cylinders of the nerves (the extremities of which have become tinted) closely enveloped by their shrivelled sheaths. The axis cylinder certainly does *not* disappear; it remains persistent in the same way as it has been demonstrated to do in the cut nerve, and the hypertrophy of the interstitial connective tissue in the degenerating columns of the cord also has its parallel in the growth of the same elements between the wasting fibres of the nerve which has been severed from its central connections. The occurrence of crowds of granulation-corpuscles in the degenerating tracts of the

spinal cord is very characteristic of this species of change; it was to their presence that Türck principally called attention as the result of his microscopic examination; it is owing to their presence that we are enabled to trace with comparative ease the extent and distribution of the areas of degeneration; whilst, lastly, it is owing to the different proportions in which these are met with, in different stages of the disease, that the affected columns vary in appearance. During the first five or six months, at least, after the setting in of these changes, the granulation-corpuscles are most thickly sown through the degenerated tracts, which either retain the dead white colour of the healthy columns, or are tinted of the faintest yellowish hue. Up to this time, too, there is not the slightest shrinking —the wasting of the nerve-fibres has been exactly compensated by the formation of granule-corpuscles and the hypertrophy of the neuroglia on interstitial connective tissue. In the later stages we may get an actual shrinking or loss of substance, owing to the gradual absorption of the granulation corpuscles and the consolidation of the fibrous tissue. In proportion as such changes occur so also do we get alterations of colour: the dead white appearance is gradually supplanted by a greyish, or semi-transparent bluish grey aspect of the diseased columns.

Microscopical examination of the cord.—A transverse section of the hardened cord, through the upper part of the cervical enlargement (apparently corresponding with the interval between the fifth and sixth cervical nerves), showed a large rupture extending obliquely from before backwards across the grey matter of the right side, as well as a considerable shrinking in the antero-posterior direction, and a loss of symmetry of the same side of the cord (Fig. 7, Plate X). On examining this transverse section under a low power and by reflected light, it was seen that not only were the inner adjacent portions of each anterior column opaque white (as could be ascertained by the naked eye), from the presence of an innumerable quantity of granulation-corpuscles, but that bodies of the same kind were scattered more sparingly throughout other portions of the white matter of the cord,

and also in the situation of the grey matter on the right side. On the left side, the outline of the grey matter was quite distinct, and its section presented a normal appearance; whilst on the right side, on account of the large rupture extending completely through the grey matter, together with the opacity of the tissue from the granulation-corpuscles around, the outline of the grey matter could not be detected at all. From the examination of thinner sections which were prepared by Lockhart Clarke's method,[1] so as to make them transparent, and were then inspected by transmitted light, it was at once ascertained that, in those regions where granulation-corpuscles had been seen most abundantly in the sections submitted to reflected light, there was a great diminution in the number of healthy nerve-fibres, and a great increase in the quantity of interstitial connective tissue. It was seen, moreover, that the edges of the ruptured nerve tissue contained a large amount of connective tissue, and that the surrounding nerve matter contained also an increased quantity of this element. From the appearance presented by the section, it seems almost certain that originally the rent in the grey matter on the right side had been most extensive, but that at the time of death a certain amount of repair had taken place, owing to the development of connective tissue, by the contractile properties of which, also, this half of the cord had been drawn in, and so had lost its symmetry.

I may as well state at once that, in the examination of this and other sections of the cord, I have always found the atrophy of nerve-fibres and the hypertrophy of connective tissue, existing in any particular part, in direct proportion to the number of granulation-corpuscles; and that in all the figures I have endeavoured to represent the relative number of granulation-corpuscles by the greater or less intensity of the dotted shading.

In a section one quarter of an inch below the last (Plate X, fig. 8) there was still a slight want of symmetry on the right side of the cord, though it was much less than in the region just above it. There was no longer any rupture to

[1] And also by methods of my own which will be described in the third number (November, 1867) of the 'Journal of Anatomy and Physiology' (Cambridge).

be seen in the same direction as in the last figure, but a smaller one in a direction almost at right angles to it, also extending through the grey matter, and continued outwards and forwards almost to the surface by a band of cicatricial fibrous tissue. The degeneration of the inner parts of the anterior columns was now about equal in amount on each side, and more uniform in depth of shading over different parts of their surface. Two rounded and very dark patches of degeneration were seen posterior to the rupture, and somewhat lighter ones at different parts of the periphery of this half of the cord. Over other portions of it granulation-corpuscles were scattered more sparingly, and the outline of the grey matter on this side still could not be detected. The number of granulation-corpuscles in the left half of the cord was somewhat less than in the last section: the grey matter on this side still presented a healthy appearance. In sections of the cord one quarter of an inch below the last (Plate X, fig. 9) the symmetry of its two sides was almost perfect, and the outline of the grey matter could now be detected in its right half, although more than one half of its surface was occupied by a large and almost square patch of dead white tissue which was made up of granulation-corpuscles, thickly sewn amongst interlacing bands of new fibrous tissue. And in transparent sections, there could be seen, in several parts of the circumference of this patch, the sheaths of blood-vessels filled with amorphous granules of blood-pigment, of a dark olive-yellow colour (Plate XI, fig. 21), whose presence clearly indicated an original rupture of blood-vessels in this situation. The degeneration of the anterior columns is now seen most distinctly to be broader, and to present a more regular border on the right than on the left side. A considerable amount of opacity from granulation-corpuscles is seen in the white matter surrounding the right half of the grey substance, and also over nearly the whole of this half of the cord. The right half, on the contrary, with the exception of the anterior column, is seen to be freer from granulation-corpuscles than it was in the last section; a few only being seen in the inner and posterior part of the lateral column.

In sections one third of an inch below the last (Plate X, fig. 10), the opaque patch in the grey matter of the right side no longer existed; almost the whole of this half of the cord was considerably clouded, and the outline of the grey matter could scarcely be detected, whilst running through its entire extent in an antero-posterior direction was another irregular rupture across the grey matter. In the anterior part of the grey matter of the left side there was a shorter and much smaller rupture, with a slight opacity round it, and in the whole of this half of the cord, more especially around the posterior grey cornu, there was a sparing distribution of granulation-corpuscles. The anterior columns were in much the same condition as in the last section. In sections one third of an inch lower down (Plate X, fig. 11) the rupture through the grey substance on the right side no longer existed; this had resumed its healthy appearance. In the centre of the grey matter of the left side, however, two small solutions of continuity were seen. The anterior columns presented much the same appearance as before, but the remainder of the right half of the section was much clearer than it is represented in the last figure—the principal area of degeneration being a somewhat semicircular one in the posterior part of the lateral column. A few corpuscles were seen also, on this side, in the part of the posterior column next the grey matter, and in the lateral column in front of what Clarke calls the *tractus intermedio lateralis*. A few granulation-corpuscles were also scattered over the left half of the section, but they were very sparse, and only formed a distinct aggregation in the posterior part of the lateral columns, in a situation corresponding with the much larger and more marked area of degeneration in the opposite half of the cord. In sections made two thirds of an inch below the last, and just below the cervical enlargement (Plate X, fig. 12), no ruptures are seen in any part; the large and well-marked areas of degeneration in the anterior columns are somewhat different in shape, the peripheral portions being broader and more extended towards the lateral columns, whilst that on the right still continues rather more extensive than the one on the left side. There

are a very few thinly-scattered granules in the anterior part of the right lateral column, whilst in the posterior portion there is a continuation of the area seen in the last section, which now has an obtuse wedge-like shape, with its apex at the *tractus intermedio lateralis*, and its base, which becomes gradually less defined, falling short of the periphery of the cord, so as to leave a strip of healthy tissue on its outer side. In the corresponding region of the opposite half of the cord, there are some scattered granulation-corpuscles as in the last section, but the grey matter and other parts of the white substance present a healthy appearance. This arrangement continued for some distance, and was found to prevail with but slight variation, even in the mid-dorsal region (Plate X, fig. 13), where we see a continuation of the alteration in shape of the areas of degeneration in the anterior columns, such as we saw commencing in the last section. At the periphery, these patches now extend fairly as far as the lateral columns. The scattered granules in the anterior part of the right lateral column have disappeared, whilst the area in its posterior part has again become more semicircular, and its outer boundary almost reaches the periphery in this region. The few scattered granules in the corresponding area of the opposite side exist as in the last section, whilst the remaining parts have a healthy appearance.

In the lower part of dorsal region, one inch above the lumbar enlargement (Plate X, fig. 14), there was an even more appreciable alteration in the shape of the anterior areas of degeneration, their outline having become more like what it was in the lower cervical region (Plate X, fig. 10), owing to the resumption of the bluntly-rounded shape of the posterior or central extremities of these areas, which had become acutely wedge-shaped in the mid-dorsal region and contiguous parts, and also to the greatly diminished extent of the peripheral expansion of these areas. In the outer part of each, not far from its external extremity, there is a distinct notch, owing to the encroachment of healthy fibres on the diseased areas. The patch in the posterior part of the right lateral column is very distinct still, and now undoubtedly extends

quite to the surface of the cord. The scattered corpuscles in the corresponding region of opposite side are rather fewer in number, but are also situated rather more externally than they were in the sections above. The gradual wearing out of the diseased fibres and the diminution in the number of granulation-corpuscles were well seen in sections lower down, made through various parts of the lumbar enlargement, and have been represented in Plate XI, fig. 15, showing a section through the upper part of lumbar enlargement, and one inch below the last; in fig. 16, which represents a section made three eighths of an inch lower still; and in fig. 17, which was copied from a section made through the lower third of the lumbar enlargement, three fourths of an inch from the commencement of the *filum terminale*. In these it will be seen that the disease disappears first, most notably from the outer parts of the patches in the anterior columns, although at the same time a thinning-out of the diseased fibres takes place also in the inner parts of the same areas of degeneration. In the posterior part of the lateral columns, also, the atrophied fibres and granulation-corpuscles are gradually replaced by healthy nerve-fibres.

From this description it will be seen that the principal one of the original lesions or ruptures of the cord was situated in the upper part of the cervical enlargement, though there is every reason to believe that one or two other important lesions must have been situated in the portion of cord immediately above this, which was unfortunately not preserved. The large oblique rupture represented in Plate X, fig. 7, gradually diminished in extent, and one quarter of an inch lower down became continuous with another smaller rupture in an opposite direction (Plate X, fig. 8). Opposite this first section there had been the greatest damage to the cord, which had been followed by a certain amount of shrinking on the injured side. From the fact that already degeneration was well marked in the inner part of each anterior column, it is almost certain that there must have been another lesion higher up, which had severed the connection between these nerve-fibres and their ganglionic cells. It will be seen,

however, that in this first section the area of degeneration is more extensive in the left than the right anterior column, whilst an inspection of all the figures below will show that the area of degeneration in the right anterior column, instead of being less than that in the left, is decidedly more extensive. This is readily accounted for by the fact that the rupture in the section represented in Plate X, fig. 7, extends into the anterior column of the right side and must have torn across many of its fibres.

In Plate X, fig. 9, there is represented a large square patch in the midst of the grey matter of the right side; this is a section through a diseased portion of the grey matter which was found to extend for a short distance above and below. Now, secondary degeneration, such as we see in the white columns of the cord, never exists in the grey matter, and the limited extent of the patch would also serve to place it in another category. From the fact that in different parts of its circumference, in different sections, I have seen blood-vessels, or rather the sheaths of blood-vessels, such as I have represented in Plate XI, fig. 21, perfectly loaded with altered blood-pigment, it seems most probable that several of the small blood-vessels supplying this portion of the grey matter had been ruptured by the original concussion, leading to effusions of blood into their sheaths and hence obliteration of the vessels themselves from external pressure. The vascular supply to this portion of nerve-tissue being cut off or seriously diminished, the tissue underwent a process of softening, which, at the period of the man's death, showed itself in the stage of repair; it was then made up, for the most part, of well-developed interlacing bundles of fibrous tissue, thickly sown with granulation-corpuscles. In all the sections such as are represented by the first three figures I have described, there was a certain irregular amount of degeneration of the fibres around the right half of the grey matter, but no well-marked area of degeneration in the posterior part of the lateral column.

In Plate X, fig. 10, we again find another distinct rupture completely through the grey matter of the right side; the original of this extended upwards and downwards for a length

of half an inch. A very small rupture also existed in the grey matter of the opposite side. On each side of the posterior half of the rupture on the right side there were considerable patches of degenerated tissue, the inner being in the outer part of the posterior columns (which I shall speak of hereafter), whilst the outer was in the posterior part of the lateral column. Seeing that a well-defined area of degeneration is to be recognised in all the remaining sections in this same posterior part of the lateral column, and that this place corresponds with the situation occupied by the fibres of that portion of the left anterior pyramid which decussates, it would seem almost certain that this area of degeneration is due for the most part to a solution of continuity of these very fibres which have been well named, collectively, by Bouchard, the "*faisceau encéphalique croisé ou externe.*" It would seem, also, almost certain, since no such area is to be recognised in Plate X, figs. 7, 8, or 9, that this band of fibres must have been torn across by the extensive rupture shown in fig. 10, and that in this situation (somewhere about the middle of the cervical enlargement) these fibres must have been situated fairly in the grey matter of the right side, and have been just about to emerge into the posterior part of the lateral column. Thus we get most valuable anatomical evidence as to the place of emergence from the grey matter of this bundle of fibres. In the lower part of the cervical enlargement and in the upper dorsal region the area of degeneration does not extend to the surface of the cord; in the mid-dorsal region and thence downwards, however, the outermost fibres are situated quite at the surface of the cord.[1]

[1] This is in accordance also with the experience of Bouchard, who, towards the end of his memoir, speaking of a case in which the secondary degeneration or sclerosis of the lateral column of the cord was extremely well marked, says:—"Je dois dire que la sclérose atteignait la meninge vers le milieu de la region dorsale, au lieu de former une bandelette complétement entourée par la substance blanche saine. J'avais donc été trop absolu dans la première partie de ce travail en disant qu'aucune fibre du faisceau encéphalique croisé n'arrivait au contact de la pie-mère."

The other cerebral fibres situated in the cord—in addition to the band in the posterior part of each lateral column which is formed by the decussating fibres of the pyramids—are lodged in the inner part of each anterior column. This band, which Bouchard names "*faisceau encéphalique direct ou interne*," seems to be made up by those fibres of the anterior pyramids which do not decussate. This conclusion has been arrived at from the fact that, in cases of extensive cerebral lesion leading to secondary degeneration of the spinal cord, the diseased tract can be traced downwards through the crus cerebri on the same side as the lesion; through the corresponding half of the pons, the pyramid of the same side; and, lastly, along the inner part of the anterior fissure of the cord on the same side, and the posterior part of the lateral column on the opposite side. From the observations made in the present case if would seem, as I have above pointed out, that this decussating band only reaches the lateral column opposite the middle of the cervical enlargement. And inasmuch as in no case of secondary degeneration, according to Bouchard, has there been noted any alteration of the roots of the spinal nerves, it is presumed that the degenerated fibres do not pass into them, but that they terminate gradually at different levels by passing into the grey matter of the cord, and there being continuous with certain of the large nerve-cells of the anterior cornu. The number of fibres in this lateral band gradually diminishes in the lower parts of the cord, though certain of them may be traced, as in the present case, even into the lower part of the lumbar enlargement. But, whilst Bouchard admits this also, he says, with regard to the direct encephalic fibres in the cord, that the longest of them do not extend farther than the middle of the dorsal region. This dictum seems directly contradicted by what we have seen in the present case, where the degeneration of the inner part of the anterior columns only wears itself out most gradually in descending to the lower part of the lumbar region, probably from the gradual passage of its fibres into the grey matter. But this thinning-out of the diseased fibres is not perceptible at all until we get

to the lower dorsal region, and the diminishing areas can be traced with the greatest ease, even into the lower third of the lumber enlargement.

In addition to the bands of encephalic fibres occupying the inner part of the anterior column and the posterior part of the lateral, each antero-lateral column is made up of a number of *commissural* fibres which belong entirely to the spinal cord, and which also have their nutritive centres at their upper extremities. These occupy the whole intermediate space between the two bands of encephalic fibres, and their office seems to be that of longitudinal commissures between groups of cells in the grey matter, situated slightly above one another. Bouchard names them "short commissural fibres;" and he speaks of certain others, much fewer in number, and situated just in front and to the outer side of the external encephalic band (also having their nutritive centres above), which extend for a much greater distance through the cord. These he names "long commissural fibres."[1] Concerning the latter class of fibres, the present case cannot be said to furnish any evidence either positive or negative; but many of the scattered granulation-corpuscles in figs. 7–11 (Plate X), doubtless mark the situation of atrophied short commissural fibres, which, at a level just below the cervical enlargement, have all disappeared with the exception of a few in the anterior part of the right lateral column (fig. 12, Plate X): in the next section represented these also have vanished.

In this, as in other cases of secondary degeneration of the spinal cord, no atrophy either of the anterior or of the posterior nerve roots could be detected.

We now come to the consideration of the degenerations of the posterior columns in the upper cervical part of the cord, and in the medulla oblongata. These belong to another category; they are all ascending degenerations. None of the original lesions which lead to these exist in the portions of the cord about to be examined. These must have been situated in that portion of the cord (below what is about to be described and above the lesion already described in the upper part of the

[1] Loc. cit., p. 570.

cervical enlargement) which was, most unfortunately, not preserved. Inasmuch as nothing can be said, therefore, with regard to the origins of these degenerations, all I can do will be to describe their situations as they ascend through the upper part of the cord and the medulla oblongata. They occupy the posterior columns principally, but also exist in the outer and posterior part of each lateral column.

It has been known for some time that in the most external part of the posterior portion of the lateral columns above the middle of the dorsal region, there are a certain number of fibres whose nutritive cells are situated in the grey matter of the cord at their lower extremities, and which consequently degenerate in an ascending direction. Some of these fibres have been traced upwards through the corpora restiformia into the cerebellum. Areas of degeneration due to the implication of such fibres may be seen in figs. 6–1, Plate IX, marked *c*, *c'* They are seen to extend very far forward on the right side of fig. 6. They diminish rather gradually upwards, and an inspection of figs. 2 and 1 show that they occupy the outer and anterior part of each restiform body, and are situate just behind the dentate nuclei of the olivary bodies. The precise collocation of the fibres seems to vary somewhat as they ascend, judging from the different shapes presented by the same tract of degeneration at different levels.

In the posterior columns of the cord, secondary degenerations always take an ascending direction. These columns seem to be made up of a mixture of fibres, not distinctly separated from one another, part of which, as in the antero-lateral columns, are commissural, whilst the others are continuations of the posterior roots of the spinal nerves. Of these last, some travel but a very short distance amidst the other fibres of the posterior columns and then throw themselves into the grey matter, whilst the remainder travel for long distances in the posterior columns before losing themselves in the same substance. Although these ascending degenerations were pointed out by Türck, our knowledge concerning them is still very indefinite. Concerning the different kinds of fibres in the posterior columns, Bouchard says:—"On

peut demontrer cette proposition en comparant la forme de la dégénération ascendante dans les cas de compression des racines, et de compression de la moelle elle-même. Quand la dégénération succède à une lésion des racines, elle est circonscrites sur les coupes par une portion d'ellipse, la convexité de la courbe etant au avant, et ses deux extrémités reposant sur la face postérieure de la moelle; le tissu extérieur à cette ligne est parfaitment sain. Quand il y a compression de la moelle elle-même ses fibres radicales ascendantes sont atteintes sur un point de leur parcours et vout se dégénérer au-dessus du point comprimé; cependant la figure que présente la dégénération, sur les coupes de la moelle, n'est pas la même. Au lieu d'un segment d'ellipse, on a un triangle dont la base est sur la face postérieure de la moelle, le sommet vers la commissure. C'est que la dégénération porte également sur d'autres fibres qui ont leur centre trophique à leur extrémité inférieure dans la substance grise do la moelle. Ce sont des fibres médullaires propres, comme celles que nous avons indiquées dans les cordons antero-latéraux."[1]

In the present case, as before mentioned, I can say nothing with regard to the precise nature of the lesions leading to the ascending degenerations of the posterior columns. This is the more to be regretted, as they are so remarkably circumscribed and symmetrical. Sections through the lowest part preserved of the portion of spinal cord presenting these lesions, displayed what has been represented in fig. 6, Plate IX. This section is from the upper third of the cervical region of the cord, exactly 2½ inches from the point of the fourth ventricle. Four areas are seen, constituting two almost perfectly symmetrical pairs, one of which is situated in each posterior column. The most internal patches (*a*, *a'*) have an elongated elliptical form, whose more rounded anterior extremities occupy contiguous portions of the tissue skirting the posterior median fissure in its middle third, whilst their sharply-pointed posterior extremities, almost reaching the surface, slightly diverge from one another. The outer patch of each pair (*b*, *b'*) reaches forwards as far as the grey

[1] Loc. cit., p. 574.

commissure, and occupies most of the anterior third of the boundaries of the posterior median fissure. From this situation each patch extends backwards and slightly outwards, closely skirting the internal areas and terminating somewhat short of the surface. Of these the area on the right side is somewhat the larger, and terminates in a small process almost at right angles, the two together looking not unlike a man's leg and foot. Following up, first of all, the areas *a*, *a'*, through sections of the lower half of the medulla oblongata (figs. 5, 4, 3, Plate IX), we see that in this situation these areas occupy the greater part of the posterior median columns of the cord. They have become almost triangular also from the widening out of their posterior extremities, and they have extended forwards, on each side of the median fissure, as far as the grey commissure, and have consequently caused a lateral displacement of the outer areas, which, in the lower section, themselves occupied this situation. In figs. 4 and 3, also, it will be seen that the number of diseased fibres has most perceptibly diminished, and that more particularly in the centre of each patch, where small areas occupied by healthy fibres may be perceived. In fig. 2, which represents a section of the medulla immediately above the point of the fourth ventricle, the posterior median columns having as usual become greatly increased in size, still show a few granulation-corpuscles chiefly scattered through their most superficial portions. The diseased fibres have evidently much decreased in number in this situation, and further than this I have not traced them. In looking now to the outer pair of patches of degeneration (*b*, *b'*), we find them, in figs. 5, 4, and 3, evidently diminishing in extent and intensity; we find also that they occupy that portion of the posterior column which in the medulla oblongata goes by the name of *processus cuneatus*, and we see, by fig. 3, that they are situated immediately on the inner side and behind the grey cornua of this same fasciculus. Tracing them onwards in fig. 2, we find them pushed further away to the side, owing to the development of the posterior median columns, though still occupying the same position with regard to the above-named

grey cornua. In fig. 1 the diseased fibres are more scattered; they are now completely in the lateral region of the medulla, forming part of the *corpora restiformia*, and in these bodies they doubtless proceeded onwards, together with the atrophied fibres of the outer and posterior parts of the lateral columns (*c*, *c'*), into the cerebellum, though I have myself not followed them further than the situation represented in fig. 1, as the parts above were not preserved.

A small area of degeneration on the right side marked *d* may be traced through figs. 5, 4, 3 and 2, Plate IX; further than this it could not be traced, though the fibres composing it may have passed also into the right corpus restiforme, and gone to form part of those occupying the area marked *b'* in fig. 1.

As I am unable myself to say anything concerning the anatomical relationships of the fibres entering into the formation of these tracts of degeneration in the posterior columns, I cannot do better than quote from Bouchard's memoir what seems to bear directly on the subject. Speaking of the fibres which come from the lower half of the cord, he says :—"Ces fibres qui se prolongent jusqu'à la partie supérieure de la région cervicale sont toutes logées, dans l'epaisseur des faisceaux greles et des pyramides postérieures." It would seem almost certain, therefore, that many of those which form the tracts of degeneration marked *a*, *a'* in my figures must be of this kind. He then adds :—"Les fibres qui naissent de la moitié supérieure de la moelle ne paraissent pas se mélanger aux precedentes, de sorte que les faisceaux sensitifs du membre inférieur et ceux du membre supérieur resteraient, isolés les uns des autres, séparés par les sillons intermédiaires postericurs. En effet, dans un cas de compression de la moelle à la partie supérieure de la region dorsale, L. Türck a vu la dégénération occuper la partie externe des cordons postericurs. Malheureusement il n'a pas fait de coupes dans l'épaisseur de bulbe ni de la protubérance, de telle sorte que la démonstration anatomo-pathologique de la continuation d'une partie des cordons postérieurs à travers les corps restiformes fait complètement défauts." The fibres entering into

the tract marked *b*, *b'* in my case seem to correspond to some of those last mentioned by Bouchard, whether or not it be correct that they have their origin in the upper part of the dorsal region. In the present case, also, they have been fairly traced upwards through the lower part of the medulla, into the corpora restiformia, thus confirming, in a new way, that anatomical distribution of some of the fibres of the posterior columns which has been previously taught to exist by anatomists.

Having now described the various morbid appearances met with in the spinal cord, I shall give a somewhat more minute account of the actual histological components of the diseased patches. These are of three kinds, viz.: 1. Atrophied nerve-fibres; 2. New connective-tissue elements; 3. Granulation-corpuscles.

Atrophied nerve-fibres can be detected in all parts of the degenerated columns of the cord, and it seems difficult to understand how they escaped the observation of Bouchard and others. According to Bouchard, however, this has been the case. They are most easily detected after a portion of this tissue has been treated with a solution of caustic soda for a short time, then tinted with carmine and mounted in glycerine. The axis cylinder exists surrounded by the shrivelled and folded hyaline sheath of Schwann, the medullary matter having all disappeared (fig. 20 d, Plate XI). The axis cylinders vary much in size, just as they do in the healthy nerves; and it is owing to the fact that more or less of their extremities become stained with the carmine that the atrophied nerve-fibres can be so readily discovered after the tissue has remained for some hours in a carmine solution. Here and there also in the midst of the diseased tissue we meet with nerve-fibres in a healthy condition (fig. 19 and fig. 20, *e*, Plate XI).

New *connective-tissue elements* exist in the greatest abundance in the sclerosed columns. Its various nuclei and cells may also be best seen after treatment with soda, carmine, and glycerine. This large quantity of connective tissue is derived from the hypertrophy of the neuroglia or normal elements of this kind which enter into the formation of the cord. In the healthy organ it forms a very delicate fibrous framework, in whose trabeculæ—gradually becoming finer as we approach the central grey matter of the cord—the nerve-fibres are lodged. Fig. 18, Plate XI, represents the normal appearance of a portion of one of the anterior columns of the cord, and shows the delicate nature of the reticulum of connective tissue; whilst fig. 19 shows the appearance of one of the diseased anterior columns magnified to the same extent. The right half of this figure exhibits the appearance presented by a very thin section when mounted in glycerine; the most striking feature being the number of large rounded or ovoidal granulation-corpuscles, each surrounded and enclosed by a rim of connective tissue containing an abundance of nuclei. The left half of the figure represents the appearance of a similar thin section mounted in Canada balsam after saturation with turpentine: here the granulation-corpuscles, being made up of molecular fat, have been dissolved, and the fibrous alveolæ in which they were lodged are fully displayed. The two methods of investigation are, therefore, most valuable. Here and there in the midst of the diseased tissue a healthy nerve-fibre may be seen. Such fibres, either having escaped rupture by the original lesion, or having issued from the grey matter below its level, still remain entire, and in connection with their nutritive cells. When portions of the diseased tracts after tinting with carmine have been teased with needles, and are then submitted to a high magnifying power, the connective tissue is found to be made up of the finest and most delicate fibres, closely beset with more or less spherical nuclei varying in size from that of a small granular speck up to $\frac{1}{2000}''$ diameter. Some of these elements have been represented in fig. 20, Plate XI, where in addition to the fine fibres which seem to have dot-like nuclei attached to them at intervals, other somewhat coarser fibres are seen in connection with more faintly tinted, flatter cells (*c*, *c*, *c*); these vary in size and shape, and seem to be connected also (as at *c'*) with the finer fibres and dot-like nuclei. These cells contain a few rather large granules in their interior, but no distinct

nucleus. That marked *c''* strongly resembles a multipolar nerve-cell, with the exception that it contains no nucleus. There can be no question, however, that it is precisely similar in nature to the others marked *c*, *c*, *c*, and situated as they all were in the midst of the anterior white columns of the cord, it seems only possible for us to look upon them as connective-tissue elements. The large nuclei were apparently unconnected with fibres, and all intermediate sizes could be traced between them and the small dot-like forms. They existed in the greatest abundance, and seemed to represent only different ages of one and the same element. All alike became deeply stained with carmine, whilst the other description of cells of which I have spoken were only tinted of a delicate rose colour.

Granulation-corpuscles seem always destined to be misunderstood. They were formerly brought prominently forward by Gluge, who looked upon them as the products of an inflammatory process; and it was in great part owing to the prevalent reception of this doctrine that ordinary softenings of the brain, in which such corpuscles invariably occur, have been so long and erroneously regarded as necessarily inflammatory in nature. The real facts are, however, as Virchow and other pathologists have lately insisted, that such elements may be met with in any place where cells exist which are gradually losing their vitality. Almost all tissues that are falling into decay, therefore, whether physiological or pathological, may exhibit such structural elements; and whether we meet with them in the brain or spinal cord, in the lungs from degeneration of its epithelium, in the kidney from changes in the same element, or in cancerous or other cellular tumours—in all cases we may safely assume that they are formed from cells whose vitality is gone, or fast going—from cells which are gradually undergoing a process of retrograde fatty metamorphosis, preliminary to a complete molecular disintegration. I think there is no evidence whatever in proof of the assumption that such bodies originate by the gradual aggregation of molecules originally separate, and I should scarcely have considered it necessary to make these observations now had not Bouchard, in his valuable memoir,

assigned two modes of origin to the granulation-corpuscles which are so abundant in secondary degeneration of the spinal cord, both of which are, I believe, alike untenable. He seems to think that, as a rule, they are formed by the aggregation of fat-granules resulting from the molecular disintegration of the myeline of the nerve-tubes; though he suggests that some of them may also result from "la transformation granulo-graisseuse de gouttes de myéline."[1] Not to speak of the undoubted process by which bodies of this kind originate in other organs, and therefore the probability that they are produced by a similar process in this, we consider that a microscopical examination of the elements in question sufficiently disproves the theories of Bouchard, inasmuch as around most of the smaller granulation-corpuscles a very thin envelope may be detected—the original cell-wall greatly distended; whilst after tinting with carmine we can distinguish with the greatest ease, in the interior of each, and more or less covered with granules, a large spherical or ovoid nucleus, very similar to those which are found so abundantly in the free condition amidst the connective tissue fibres. This appearance I have represented in fig. 20, *a* (Plate XI), and from it I think we are almost bound to conclude that these bodies result from the fatty degeneration and repletion of nucleated cells. From what precise cells they originate, however, does not seem certain, and in the cord which I have examined the process of their formation could not be traced. It represented too late a stage of the degeneration, and in it these corpuscles were all fully formed. I should fancy from the character of the contained nucleus that the cell must have been developed around one of the original free spherical nuclei, which, perhaps, soon began to undergo a process of fatty degeneration. This, however, must be left a matter of doubt for the present.

Vessels.—In this as in other species of degeneration of nerve-tissue, the capillaries and small vessels assume what has been called an atheromatous appearance. The actual change, however, is not one of atheroma, neither is it

[1] Loc. cit., p. 284.

situated in the walls of the vessels at all. The appearance results from an accumulation of fatty elements around the vessel, though within its so-called lymphatic sheath. This Bouchard also imagined to be the real condition, although he did not feel quite sure upon the subject.[1] I, however, ascertained by an examination of some of the vessels taken from the cord in its fresh condition, that they were closely enveloped and their sheaths distended by fattily degenerated nuclei.[2] The nuclei were doubtless originally produced by a proliferation of those lining the inner surface of the perivascular sheath, and when in a state of fatty degeneration they almost exactly resemble some kinds of small pus-corpuscles. Whilst these exist in notably increased abundance within the sheaths of the vessels, many of the nuclei which also exist in the outer substance of the lymphatic sheath are much enlarged, and filled with fat-particles.

The nerve-cells in the uninjured grey matter throughout the cord presented a normal appearance. In no part of its extent were atrophied or pigmentarily degenerated nerve-cells met with.

In estimating the probable course and sequence of the changes met with in this degeneration it would seem to be as follows: the primary or initial changes commence in the nerve-fibres, and the others are more or less direct consequences of these. Thus, when a number of nerve-fibres have been severed from their nutritive ganglionic centres, and the process of degeneration of the white matter which has been described is in progress (whilst no obstruction or mechanical impediment to the flux of blood through the part exists), it seems evident that a redistribution of the nutritive pabulum amongst the elements of the tissues becomes inevitable. For, the nerve-fibres which form such a large part of the bulk of

[1] Loc. cit., p. 287.

[2] It seems to me almost certain that many of the smaller areas of granular degeneration, which have been described by Lockhart Clarke in his examinations of the cord in cases of tetanus and other morbid states, are in reality produced by this same kind of distension of the lymphatic sheath around the vessels.

the tissue, are no longer in a condition of nutritive activity, they do not select fresh material from the blood, and consequently a much larger share of pabulum is at the disposal of the intervening connective tissue. Being supplied with an excess of nutritive fluid, and, as the nerve-fibres atrophy, having more space at its disposal, it is not to be wondered at that hypertrophy of the connective tissue follows. The lymphatic sheaths of the blood-vessels have also an increase of nutritive fluid at their disposal, and this may be the first stimulus leading to the increased proliferation from their lining nuclei which has been spoken of. Their subsequent fatty degeneration, and also that of some of the newly formed connective tissue-cells, leading to the production of granulation-corpuscles, may be partly due to an instability of constitution in the elements themselves (owing to their rapid and irregular formation), and partly, as suggested by Bouchard, owing to the great abundance around them of the products of the retrograde metamorphosis of the nerve-tubes, which may still further disorder their nutrition. That these causes may be instrumental in bringing about the fatty change seems probable, from the fact that after a time the loaded condition of the vascular sheaths gradually diminishes. Granulation-corpuscles also after a time seem no longer to be produced; though when once formed of course they take some time to disappear, as this can only be brought about by molecular disintegration and absorption. These bodies are, therefore, to be found for a considerable time after the commencement of the process of degeneration, but it is now well known to those who have studied the subject that after some months the number of these bodies to be found in the diseased tracts gradually diminishes, in proportion to the length of time from their first formation; so that after the lapse of eighteen months or two years they may have all disappeared, leaving in the now shrunken tracts only atrophied nerve-fibres, and greatly hypertrophied connective tissue.

From what has been said it will be seen how nearly allied the process of cerebral or spinal softening is to that of these secondary degenerations. The regressive changes in the

nerve-tubes, the production of granulation-corpuscles, and the so-called atheromatous condition of the vessels, is the same in both cases, and in both alike the termination is in a development of new consecutive tissue.[1] In the case of secondary degenerations the change is initiated by an inability of the divided nerve-tubes to carry on their own nutrition—the pabulum being at hand they are unable to appropriate it; whilst in most cases of cerebral *ramollissement* the series of changes is more rapid, owing to their being brought about by some diminution of the proper nutritive supply either from disease or obstruction of the vessels belonging to the part.

Comments on symptoms, &c.—From what has been made known of the condition of the spinal cord we find that, as was actually the case during life, there was no reason for expecting any impairment of *sensation* in the paralysed parts. Sensory impressions are conveyed to the brain principally, if not entirely, through the central grey matter, and it has been abundantly proved that such local lesions of the grey matter, as I have shown to exist in this case on the right side, are by no means sufficient to stop the transmission of sensory impressions; at the most they could only bring about a degree of retardation in the rapidity of their transmission. There was in this case imperfect *paralysis* of the right arm and of both lower extremities, and the examination of the cord has shown such important lesions in the upper and middle parts of the cervical enlargement on its right side, as fully to account for this paralysis of the right arm, whilst the degeneration of the anterior columns and of the posterior parts of the lateral columns showed that the encephalic fibres in these situations were functionally inert; and inasmuch as this condition of degeneration extended downwards into the lower part of the lumbar enlargement (although gradually diminishing in extent), we have an explanation also of the partial paralysis of the lower extremities.

[1] Reynolds's 'System of Medicine,' vol. ii, article "Non-Inflammatory Softening."

Although we have no clinical records of a difference in the amount of power possessed over the two extremities, there is reason to believe from the much greater extent of the degeneration in the posterior parts of the right lateral column that the capability of voluntary movement must have been less on this side than on the left. The *startings* of the limbs—more especially of the right lower extremity—which was complained of after the first ten days and for some time subsequently, was doubtless to be attributed to the irritation of healthy nerve-fibres proceeding to the limbs, owing to the reparatory process at the seat of the original lesions in the cervical region. The secondary degenerations which must have been making progress at that time in the anterior and lateral columns, could not of themselves cause any symptoms, since the mere fact of the degeneration taking place in them was of itself evidence that they were functionally inert and cut off from their physiological and nutritive centres. The state of *rigid contraction* which the muscles of the right arm subsequently assumed, appears to have commenced about two months after the accident; beginning almost imperceptibly and gradually increasing, as it is stated to do by Bouchard.[1] It is certainly a question of some difficulty to ascertain the exact cause of this late rigidity coming on in paralysed parts. Some hold that it is entirely due to changes in the paralysed muscles themselves; others, such as the late Dr. Todd, ascribe to it a cerebral origin, and believe it to result from the irritation produced by the contraction and cicatrization of a brain lesion. Bouchard, however, is not a believer in either of these explanations, and thinks that in all cases, whether the paralysis be of cerebral or of spinal origin, the cause of late rigidity in the paralysed muscles is to be ascribed to changes taking place in the spinal cord itself. He believes that now we know of the invariable existence of secondary degeneration of the spinal cord in cases of apoplexy depending upon lesions of the corpora striata, optic thalami, or pons, we need no longer look for the cause of this late rigidity in the brain itself; but that it is explicable in the

[1] Loc. cit., p. 292.

same way as in cases of paralysis due to original lesions of the spinal cord, from a consideration of the natural progress of the secondary degenerations in this organ. He thinks, in fact, that this important symptom is due to an irritation of adjacent healthy fibres, when the new growth of connective tissue taking place in the diseased tracts, comes to press upon or encroach amongst the healthy fibres. The suggestion is ingenious and deserving of consideration, though there seem difficulties in the way of its acceptance. Time will not permit of my discussing these questions, however, and I must pass on to the next symptom—that of *pain* in the paralysed limbs. Although only slightly mentioned in the clinical record, I call attention to it now, since MM. Charcot and Cornil[1] have lately made some investigations as to the cause and treatment of this, which is oftentimes a most distressing symptom. They believe it to be due to a kind of hypertrophic neuritis in the affected limb, since they have found the nerves increased in volume, more vascular than natural, and having a notable increase in the thickness of their connective tissue envelopes. Whether this change is due to mere functional inertia or is more directly dependent upon the secondary degenerations of the cord is not known. It seems, however, to have an evident relation to the pains above mentioned, and, according to M. Charcot, these are not only increased by pressure along the course of the nerves, but are often soothed by the application of a blister in this situation.

The *respiration* was described as being diaphragmatic when the patient was admitted into the hospital, but it seems probable, from the condition of the cord, as well as from the length of time that the man lived without fatal engorgement of his lungs, that there was by no means complete paralysis of the thoracic and abdominal muscles of respiration. Their action was doubtless much impaired, and hence amongst other things the extreme difficulty the man had in expectorating the mucus with which his bronchial tubes were loaded for some time before his death. Fortunately, the lesions of

[1] 'Compt. Rend. de la Soc. de Biolog.,' 1863.

the grey matter did not extend quite so high as the origins of the phrenic nerves, and the diaphragm was therefore unaffected. Had it been otherwise—even though one side only were affected—death would, in all probability, have been very rapid.

It now only remains for me to say a few words concerning the *general muscular atrophy*, which commenced about two months after the accident, and which in the remaining four months of the man's life had reduced him almost to a skeleton. This atrophy following paralysis has been frequently noticed, and not unfrequently it has been confounded with 'progressive muscular atrophy,' which should, however, be regarded as a distinct disease. Unfortunately, having my attention so much attracted to the spinal cord at the time of the post-mortem, I altogether omitted to make any special examination of the atrophied muscles, though I did take out and put into chromic acid for subsequent examination the great semilunar ganglia of the sympathetic system. A careful inspection of them and a comparison with others removed from patients dying of different diseases, enables me to say that these ganglia were undoubtedly atrophied: they were scarcely as much as one third of their usual size, and whilst all other parts of the body were remarkable for the almost total absence of fat, on making thin sections of these bodies and then placing them under the microscope, certainly a larger proportion of thin fluid fat was seen than is usually met with in such sections. The ganglion-cells seemed to contain rather more than their usual amount of pigment; they were more highly refractive also than in other sections with which I compared them, and the nucleus and nucleolus, which are usually so apparent in these cells, could scarcely be distinguished in one out of twenty of the ganglion-cells, in sections of portions of the sympathetic belonging to our patient. These were the only abnormal conditions that I was able to detect in the semilunar ganglia, and other parts of the sympathetic system were not examined.

These changes met with in a limited part of the sympathetic system, although not very decided, will, I hope, be

sufficient to attract increased attention to the condition of the sympathetic system in other cases of paralysis followed by muscular atrophy. In addition to the muscular atrophy in this case, there were other conditions which might have been dependent upon a disease of the sympathetic system; since the post-mortem examination revealed an abnormal condition of the liver, apparently due to fatty degeneration, tubercle in the lungs, and disease of the kidneys; whilst during life there was constant vomiting. If the muscular atrophy and degeneration of viscera were in reality due to a morbid condition of the sympathetic in this case, we should have to look upon this as secondarily affected, and as a result of the primary disease of the spinal cord; whilst in progressive muscular atrophy, M. Jules Simon, a late able writer on the subject,[1] maintains that some abnormal condition of the sympathetic system is the starting-point of the disease, which secondarily affects the muscular system and some of the anterior roots of the spinal nerves. In this view he is supported more or less entirely by Dumenil, Schneevoogt, Remak, Bärwinkel, Jaccond, and Professor Trousseau; and MM. Schneevoogt,[2] and Jaccoud[3] have published most important cases in which unmistakeable fatty degeneration of the sympathetic system was met with. It is only fair to add, however, that some still adhere to Cruveilhier's doctrine of the dependence of this disease upon a disease of the anterior roots of the spinal nerves; whilst others, such as Duchenne, Virchow, and Aran believe the disease to be a primary one of the muscles themselves.

I may say, in conclusion, that the prognosis does not seem quite hopeless in cases of secondary degeneration of the spinal cord, even after the supervention of late rigidity in the paralysed muscles, since M. Bouchard has seen a cure result in five such cases.[4] These were all cases of complete

[1] 'Nouv. Dict. de Méd. et de Chirurg.,' vol. iv, 1866, article "Atrophie Musculaire Progressive."
[2] Nederlandisch, 'Lancet,' 1854, and Schmidt's 'Jahrb.,' 1855.
[3] 'Mém. de la Soc. Méd. des Hôpitaux,' November, 1864.
[4] Loc. cit., p. 297.

paraplegia, from compression of the cord due to Potts' curvature. He says: "Dans 4 cas la sensibilite et le mouvement ont reparu avec touté leur intégrité; dans 1 seul, les mouvements, sans avoir recouvré leur entière liberté, permettent cépendant à la malade de marcher. Dans ce cas la paraplégie était flasque; dans les autres elle s'accompagnait de contracture." "On peut donc, en conclure que les tubes nerveux de la moelle peuvent se régénérer comme ceux des nerfs périphériques, non seulement chez l'enfant, mais encore chez l'adulte et lors même que les faisceaux dégénérés, ont été déjà le siége d'un travail d' hypergénèse des éléments nucléaires."

If what I have already stated concerning the persistence in the degenerated tracts of the axis cylinders of the nerves be borne in mind, it seems probable that the repair in these cases is brought about in the same manner as when it occurs in peripheral nerves. Here MM. Phillipeaux and Vulpian have convinced themselves that the restoration of function is due to the reproduction of myeline around the persistent axis cylinders of the nerve-fibres rather than to the production of entirely new fibres, as it was formerly imagined. Notwithstanding the evidence afforded by the recovery of the patients above mentioned, and his knowledge of the manner in which restoration of function was brought about in divided nerves, Bouchard imagined that the atrophied nerve-fibres entirely disappeared in the spinal cord; but my statement that the axis cylinders of the fibres are easily recognisable in the disease columns, though resting upon evidence indubitable to myself, receives additional confirmation from these clinical facts.

DESCRIPTION OF PLATES IX, X, AND XI.[1]

PLATE IX.

Fig. 6.—Transverse section through upper cervical part of spinal cord ($2\frac{1}{2}$" below point of fourth ventricle), showing two pairs of almost symmetrical and well-defined areas of degeneration in posterior columns of cord (a, a' and b, b'), and also unequal areas of degeneration in the lateral columns (c, c'). In addition there is a very slight patch of degeneration in each anterior column near the points of exit of anterior nerves.

Fig. 5.—Section $1\frac{1}{4}$" above last, which is on a level with the lower boundary of the medulla oblongata and of the decussation of the pyramids. Letters of reference same as in last figure, pointing to more limited areas of degeneration, with the addition of d, another small patch situated just beneath the neck of the right "grey tubercle of Rolando."

Fig. 4.—Section through medulla $\frac{1}{2}$" above last and $\frac{1}{12}$" below point of fourth ventricle. Letters of reference same as in last figure. The median patches of degeneration marked a, a' have become wider, and now contain some healthy fibres in their midst. They are seen very distinctly, by this figure and the next, to occupy the posterior median columns of the cord.

Fig. 3.—Section through medulla $\frac{1}{4}$" above last, and $\frac{1}{12}$" below the point of the fourth ventricle. Decussation of pyramids not represented in this or other figures. Letters of reference same as in Fig. 5, pointing to gradually waning areas of degeneration. The single area, d, on right side, is now seen to intervene between the much enlarged "grey tubercle of Rolando" and the cornu of the "processus cuneatus." The areas a, a' have increased in width with the posterior columns, and contain much more of healthy tissue in their midst.

Fig. 2.—Section through medulla just above point of fourth ventricle. The widened posterior median columns in this situation are almost composed of healthy tissue, and show only a very slight cloudiness externally. The areas b, b' and c, c' are more limited and much less obvious, and the same is the case with the area d, on the outer side of the cornu of the processus cuneatus.

Fig. 1.—Section of medulla higher up through the middle of olivary bodies. The areas a, a' have disappeared with the posterior median columns; the area d has also disappeared; whilst the areas b, b', now occupying the restiform bodies, have become rather lateral than posterior; they are much fainter and more diffuse. The areas c, c', in the anterior borders of the restiform bodies, have also nearly disappeared.

[1] Each of the sections through the medulla oblongata and the spinal cord is represented twice its natural size.

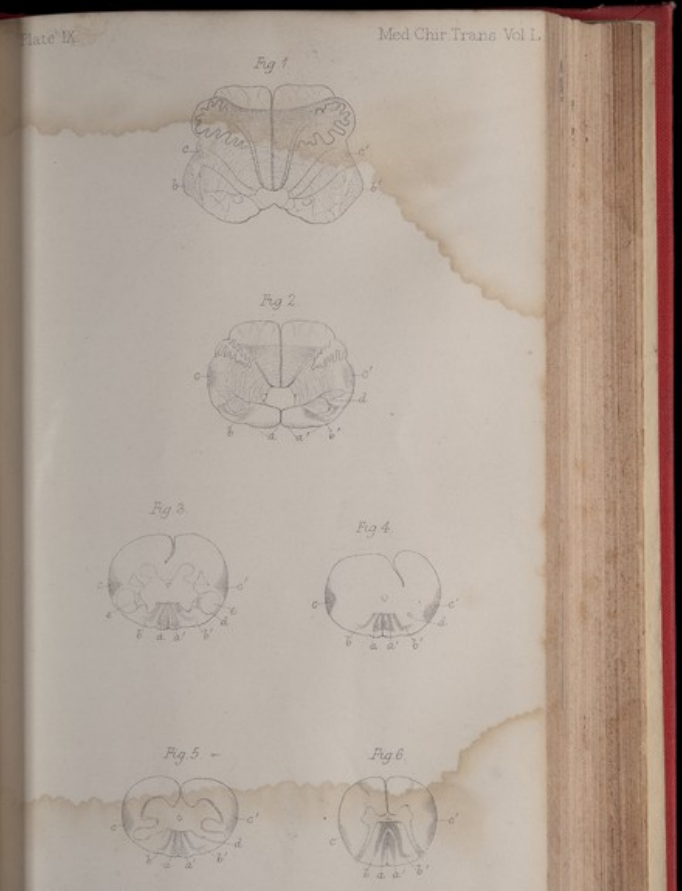


Plate X.

Fig. 7.—Section through upper part of cervical enlargement, showing a large oblique rupture through the grey matter and a part of the right anterior column, with a contraction and want of symmetry in this portion of the cord. The anterior columns on each side, more especially left, have undergone degeneration, and other parts of the cord present granulation-corpuscles either in groups or sparsely scattered. The grey matter on left side is unaffected.

Fig. 8.—Section ¼″ below last. Want of symmetry on right side still apparent, though less marked. A smaller rupture having a different direction seen in this section, which is continuous externally with a fibrous cicatrix extending forwards and outwards to surface. Well-marked degeneration in grey matter immediately behind rupture. With the exception of anterior columns other parts of section are freer from degeneration than last.

Fig. 9.—Section ½″ below last. Symmetry almost perfect; no ruptures. Large square patch of diseased tissue in grey matter of right side. Considerable degeneration of fibres around grey matter on this side.

Fig. 10.—Section ¼″ below last. Showing a large irregular rupture extending through the whole length of the grey matter of the right side and much degeneration of tissue around it. On the left side also there is an increase in the number of granulation-corpuscles and a very slight solution of continuity in the grey matter.

Fig. 11.—Section ¼″ below last. Grey matter of right side now entire and pretty healthy. Much less degeneration of white columns also on this side, and (leaving out of consideration inner parts of anterior columns which are much the same as in last sections) what there is occupies principally a definite part of the lateral column. Two very slight ruptures in grey matter on left side, and a very slight amount of degeneration also in posterior part of left lateral column.

Fig. 12.—Section just below cervical enlargement, ¾″ below last. Showing alteration of shape of areas of degeneration in anterior column, a well-marked area in the posterior part of right lateral column, and a much fainter one on the left side. No lesions of grey matter, and other portions of section healthy, with the exception of a very slight amount of degeneration in the anterior part of right lateral column.

Fig. 13.—Section through mid-dorsal portion of cord, showing still further alteration in shape of anterior areas of degeneration, with evident approximation of the right posterior area to the periphery of the cord.

Fig. 14.—Section through the lower dorsal portion of cord, 1″ above the lumbar enlargement, showing another alteration of the shape of anterior areas. Posterior areas on each side now extending to surface of cord.

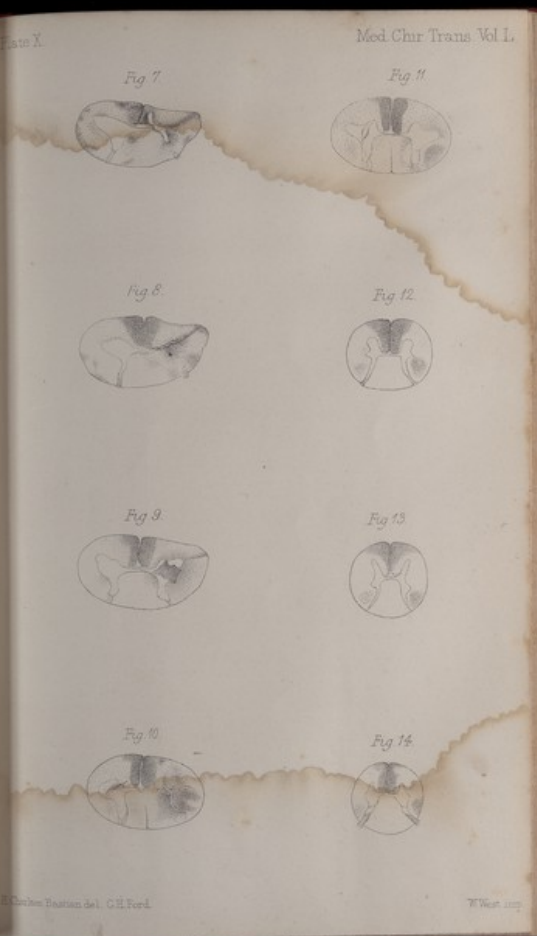


Plate XI.

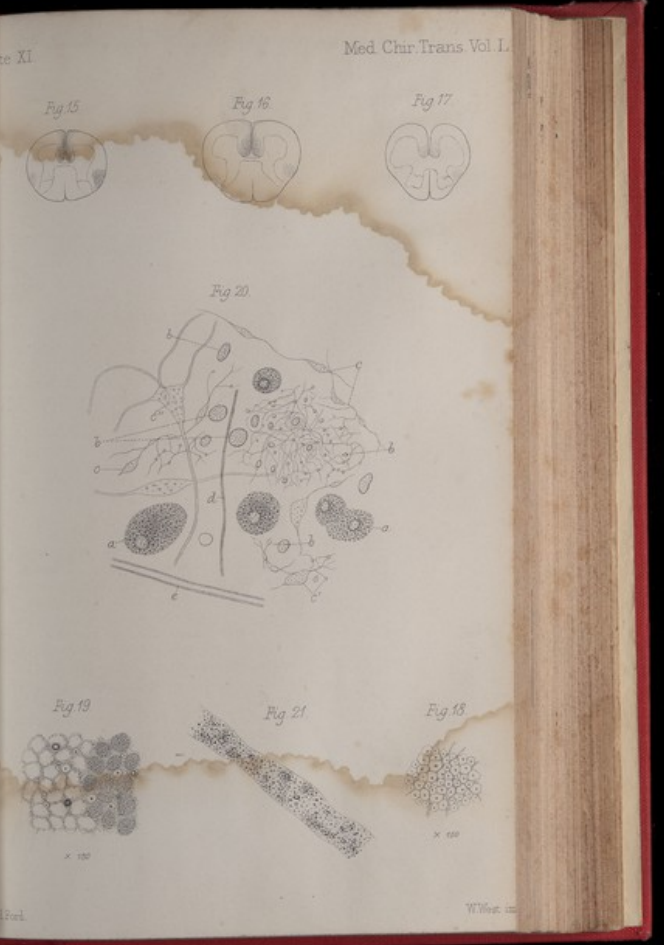
Figs. 15, 16, 17.—Sections through the upper part of the lumbar enlargement, ¾″ below this last, and through the lower third of the lumbar enlargement, or 1½″ from the commencement of the *filum terminale*. These show the gradual way in which the areas of degeneration terminate, and therefore the positions occupied by the longest of the degenerated fibres.

Fig. 18.—The appearance presented by a section through a healthy portion of one of the anterior columns of the cord, showing the sections of different sized nerve-fibres with intervening partitions of delicate fibrous tissue. Magnified 150 diameters.

Fig. 19.—The appearance of a section through a diseased portion of one of the diseased anterior columns. The right half of the figure gives the appearance of a thin section when mounted in glycerine, showing the abundance of large granulation-corpuscles separated from one another by richly nucleated connective tissue, whilst the left half shows the appearance of a similar section after immersion in turpentine and Canada balsam, when the granulation-corpuscles have been dissolved out and the fibrous alveoli in which they were situated are more plainly displayed. Here and there also in each half the sections of unaltered nerve-fibres are seen, and in the whole figure the sections of three blood-vessels are shown, whose walls are considerably thickened. Magnified 150 diameters.

Fig. 20.—Highly magnified representation of the different kinds of elements met with in the secondarily degenerated columns, as they appear after tinting with carmine:—*a*, *a*, *a*, granulation-corpuscles of different sizes, each having in its interior a well-marked nucleus; *b*, *b*, *b*, free spherical or ovoidal nuclei, such as exist in the greatest abundance, and of all sizes; *c*, *c*, *c*, branched cells of various shapes and sizes, which become much more faintly tinted with carmine than the preceding nuclei; *c'* shows the apparent connection between these two kinds of elements such as may be seen occasionally; *c''*, one of the largest and most extreme forms of these cells, closely resembling a nerve-cell; *d*, one of atrophied nerve-fibres consisting only of the axis cylinder and the delicate sheath of Schwann, which is closely wrapped round it; *e*, one of healthy nerve-fibres from midst of diseased tract. Magnified 400 diameters.

Fig. 21.—Appearance presented by one of the vessels just outside the large area of degeneration in the grey matter represented in Fig. 9. It is rather the sheath of the vessel which is seen loaded with amorphous blood-pigment of a dark yellowish olive colour and marking the site of a previous effusion of blood.



With the Author's kind regards -

OBSERVATIONS

ON THE

TACTILE SENSIBILITY OF THE HAND.

BY

EDWARD BALLARD, M.D. Lond., M.R.C.P.,

MEDICAL OFFICER OF HEALTH FOR ISLINGTON.

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Received Feb. 11th.—Read March 11th, 1862.

The observations which constitute the basis of this paper are submitted to the Royal Medical and Chirurgical Society, in the hope that they will not be regarded as uninteresting or unworthy of acceptance. In prosecuting any inquiry such as this, it is of the highest importance that the first observations should be conducted on a part which is endowed with the greatest amount of tactile sensibility. The phenomena to be noted being subjective, the great difficulty to be surmounted is the acquisition of a standard by which they may be measured. This standard must be entrusted to the memory; it must be definite and decided; and as no part of the body conveys to the intelligence more precise impressions than does the hand, so there is no part with which tactile impressions made elsewhere can be so readily compared.

The succeeding observations are limited to my own person and to my right hand, hence the numbers given apply solely to myself; probably other persons whose hand is of the same size would furnish similar results, but different

numbers would be anticipated with hands of a different size, and hence in female children and large persons. I am disposed rather to agree with Valentin, that the absolute values may differ in different persons, and that a delicate skin and an active mind may modify the absolute results of any experiments, than with Brown-Séquard, who appears to hold the opposite view. In all persons, however, we may expect that the distribution of the tactile sensibility will pretty well coincide.

The method employed in my experiments was that many years ago suggested by Weber, and since commonly employed in medical practice for purposes of diagnosis. I used the ordinary compasses, tipped with cork points; I tried other materials, but fell back upon the cork, as, after all, affording the purest kind of tactile impression; steel points, unless used very lightly, give more or less the impression of a prick, and are decidedly unpleasant, when employed upon thin-skinned parts of the body; cork may be cut with a sharp knife to a very fine point; the only objection to its use is the necessity for an occasional renewal of the points. The pieces of cork should be cut into such a shape that, when the compasses are closed, the adjoining plane surfaces shall lie together without interval, and the points lie at the same level.

The scale adopted for measurement has been the English inch divided into tenths; I used this in preference to the measurement by lines, chiefly because it is that which is, for most other purposes, in use in this country, and is supplied in every case of mathematical instruments.

The plan I adopted to represent the spots of the surface experimented upon was to mark the intended spots with a cross, and having done this I had photographs taken, so as to represent precisely the locality of each observation. For these I am indebted to the kind and ready assistance of my friend, Dr. Matthews. On these photographs I could then mark the results of the observations.

It is well known that the numbers obtainable by Weber's

method differ according to the direction in which the points are placed. When they are placed in the long axis of the part to be examined (I am speaking now of the extremities), the numbers are higher, the measurements greater, than when placed transversely. To represent accurately, therefore, in numbers the sensitiveness of a part, both these measurements must be included; I therefore measured in both directions, and have assumed *their sum to be the absolute sensitiveness of each spot*. On surfaces much curved, if the points included any considerable arc, I have dipped the points in ink, and reapplying them to the surface, have measured with tape between the dots produced, and assumed this measurement as the correct one. In the Appendix the measurements are given both as furnished by the compasses and also by the tape, where this was employed.

The mode in which the experiment is performed is also of some consequence. In experimenting on any spot, the compasses should be opened at first to a distance *less* than what is presumed will be necessary, and should be gradually opened wider and wider until the proper width is attained, that is until the two points are not only unmistakeably felt as distinct impressions, but until the consciousness assures us that there is *a distinct interval between them*. It is easier to discover the lowest measurement which will give this result by proceeding as I advise than by opening the compasses first to a greater width than is necessary and gradually lessening it. The idea of an interval once had at any spot is apt to be retained in the memory, and to vitiate the sensation imparted as the width is reduced. Another precaution I must give, and this arises from a somewhat similar cause. It is to use our experience in guessing the probable width which will be requisite so as to commence at each spot only a little below it. If we commence with too small a width, the touches on the same point will necessarily be more numerous before the proper measurement can be obtained, the attention becomes wearied, and the tactility of the part by repeated touches becomes absolutely lowered. The quicker the measurement can be obtained consistently

with all due care, the more accurate it is therefore likely to be. I will, after these preliminary remarks, proceed to detail the observations I have made. I will merely add that I have since tested their accuracy by repeating them, and that I am not aware of any equally precise or extended observations being in existence. The number of separate spots upon the hand, the tactile sensibility of which has been examined, is 142. On each spot two observations have been made, one in each direction, making thus 284 observations, each of which has been repeated several times for verification. *The mean sensibility of the entire hand*, as thus ascertained, is 1·384 in. *The lowest sensibility* at any spot was found on the dorsum, at a spot corresponding with the base of the fifth metacarpal bone; it is represented by 5·0 inches. *The highest or most acute sensibility* was found at the top of the index finger, viz., ·35 in. The range, therefore, is very extensive.

It is for me now to show how this varying sensibility is distributed.

Hand as a whole.

The sensibility of the surfaces, palmar and dorsal, and of the edges and distal extremity of the hand, have first to be examined.

Palmar surface.—1st. Including the thumb, the fingers lying in apposition, and the thumb laid at the side of the hand. —The number of spots examined on the palmar surface thus constituted (excluding the tips of the thumb and fingers) was 40. The *mean sensibility* may be represented by 1·222 in. The *lowest* sensibility was 2·0 in., and was seated at a spot corresponding to the base of the first and second metacarpal bones. The *most acute* sensibility, ·55, was found at the middle of the last phalanx of the index finger.

2nd.—But the palmar surface may be considered *excluding the thumb*. The number of spots examined thus was 34. The *mean* sensibility was 1·215 in.

Dorsal surface.—1st. The number of spots examined, including the thumb, was 40. The *mean sensibility* may be represented by 1·975 in. The *lowest* sensibility, 5·0 in., was seated opposite the base of the fifth metacarpal bone. The *highest*, ·725 in., was found to correspond with the middle of the last phalanx of both the index and little fingers.

2nd. Excluding the thumb, the number of spots examined was 34. The *mean* sensibility was 2·016 in.

Radial border.—1st. With the thumb in apposition with the border of hand.—The number of spots examined (excluding tip of thumb) was 11. The *mean* sensibility was 1·104 in.

2nd. With the thumb placed in apposition with the palm, and its tip directed towards the middle finger: the border is then formed by the interval between the first and second metacarpal bones and the border of the index finger. The number of spots examined was 10. The *mean* sensibility was 1·447.

Ulnar border.—The number of spots examined was 9. The *mean sensibility* was 1·216 in.

Distal extremity.—This is constituted by the tips of the four fingers. The *mean sensibility* of these is ·4 in.

Comparison of sensibility of the surfaces and borders generally.—1st. Including the thumb.—The order is, distal extremity, radial border, ulnar border, palmar surface, dorsal surface.

The distal extremity exceeds the radial border by 1¼ths, or is nearly three times as sensitive.
The radial border exceeds the ulnar border by over ¼th.
The ulnar border exceeds the palmar surface by quite a trifle; they may practically be regarded as identical.
The palmar surface exceeds the dorsal surface by over ⅓ths.

2nd. Excluding the thumb.—The order is, distal extremity, palmar surface, ulnar border, radial border, dorsal surface.

The distal extremity is about three times as sensitive as the palmar surface and ulnar border.
The palmar surface and ulnar border exceed the radial border by under $\frac{1}{5}$th.
The radial border exceeds the dorsal surface by over $\frac{1}{3}$ths.

Comparison of proximal and distal portions of hand.—Weber not only pointed out that the palmar surface of the hand exceeded the dorsal in sensibility, but that the sensibility increased as the distal extremity of the hand was approached. He determined this by the apparent increase in the distance between the points of the compasses when these were fixed, but applied successively to parts nearer and nearer to the extremity of the hand. "In manu autem," he says, "hoc annotandum est, tactum in volari superficie subtiliorem esse quam in dorsali, simul autem eo auctiorem deprehendi, quo propior locus in manu apicibus digitorum est." ('Annotationes Anatom. et Physiol.,' prol. viii.)

An accurate appreciation of this fact may be obtained from the observations I have tabulated, in various ways. 1st. We may compare the metacarpal with the digital portions of the hand generally, and those of the palmar and dorsal surfaces in particular, as well as the metacarpal and digital portions of the borders. 2nd. We may examine anatomically corresponding spots which lie in one line across the hand with those which lie in other lines nearer to the apex, both as they form zones on the surfaces and edges and lines on the palmar and dorsal surfaces in particular. 3rd. We may trace the same law as pertaining to zones at corresponding anatomical parts in the fingers. This last mode I shall defer until I treat of the fingers specially.

I. *Comparison of metacarpal and digital portions of hand generally.*—The anatomical peculiarities of the thumb, which consists of three in place of four bones, and is so situated and arranged as to form, as it were, an opposable hand, render it convenient to exclude this organ from the present comparison, as well as from most of those which succeed. It will be more convenient to consider it separately.

Metacarpal portion of hand, generally, mean of 24 spots, 2·58 in.
Digital „ „ 94 „ 1·045

The digital portion of the hand generally (excluding the thumb) exceeds the metacarpal in sensibility, being, in fact, about one and a half time more sensitive.

Comparison of the metacarpo-palmar and digito-palmar regions (exclusive of tips of fingers).—

Metacarpo-palmar region, mean of 10 spots, 1·750 in.
Digito-palmar „ „ 24 „ ·992

The digito-palmar region, then, exceeds the metacarpo-palmar in sensibility by nearly four fifths.

Comparison of the metacarpo-dorsal and digito-dorsal regions.—

Metacarpo-dorsal region, mean of 10 spots, 3·770 in.
Digito-dorsal „ „ 24 „ 1·285

The digito-dorsal region, then, is about three times more sensitive than the metacarpo-dorsal. The greatest difference, then, between the metacarpal and digital regions exists on the dorsal surface of the hand.

Comparison of the metacarpo-palmar and metacarpo-dorsal regions, and of the digito-palmar and digito-dorsal, respectively.—The above numbers enable us to effect this. In the metacarpal portion of the hand the palmar surface is more than twice as sensitive as the dorsal. In the digital portion the palmar exceeds the dorsal in sensibility to much less extent, viz., by about one third. The principal difference, then, between the palmar and dorsal surfaces is found in the metacarpal part of the hand.

Comparison of the metacarpal and digital portions of the radial border of hand.—For the purposes of this comparison we may consider the metacarpal border as formed by the interval between the metacarpal bone of the thumb and that of the index finger.

Metacarpal portion of border, mean of 4 spots, 2·41 in.
Digital „ „ 6 „ ·804

Or the digital portion of the border is three times more sensitive than the metacarpal.

Comparison of the metacarpal and digital portions of the ulnar border of hand.—

Metacarpal portion of border, mean of 3 spots, 1·833 in.
Digital „ „ 6 „ ·908

Or the digital portion of this border is twice as sensitive as the metacarpal.

Comparison of the metacarpal borders and digital borders of hand respectively.—The above numbers enable us to effect this. In the position of the thumb here assumed, the metacarpo-ulnar border exceeds the metacarpo-radial by about one third. The digito-radial border (radial border of index) exceeds in sensibility the digito-ulnar (ulnar border of little finger) by about one eighth.

If we take the other view of the radial border of the hand, as constituted by the radial side of the thumb, and regard parts lying between the same parallels in place of parts corresponding anatomically, we may compare the proximal portions of the two edges thus:

Proximal part of radial border of hand, mean of 5 spots, 1·585 in.
Metacarpal portion of ulnar „ „ 3 „ 1·833

Thus viewed, the radial border will, in this proximal part, exceed the ulnar in sensibility by about one sixth.

Comparison of the metacarpal borders with the metacarpal surfaces (dorsal and palmar).—

Radial metacarpal border (including border of thumb), mean of 5 spots, 1·585 in.
Metacarpo-palmar surface (including that of thumb and its palmar surface to phalangeal joint), mean of 14 spots, 1·596 in.

In this view the radial border of the proximal portion of the hand and the palmar surface of the same are of about equal mean sensibility.

On the other view, where the metacarpo-radial border is formed by the interval between the first or second metacarpal bones, the metacarpo-palmar surface exceeds it in sensibility by above one third.

Radial metacarpal border (including border of thumb), mean of 5 spots, 1·585 in.
Metacarpo-dorsal surface (including that of thumb to 1st phalangeal joint), mean of 18 spots, 3·080 in.

In this view the radial border of the proximal portion of the hand has almost twice the mean sensibility of the metacarpo-dorsal surface.

In the other view the radial border exceeds the metacarpo-dorsal surface by about three fifths.

The metacarpo-ulnar border is less in mean sensibility than the metacarpo-palmar surface (as partly formed by thumb), the latter exceeding it by about one seventh. The same is the case where the thumb is excluded from calculation, but the difference is very much less, the palmar surface exceeding it by only a small fraction (about one twenty-first).

The metacarpo-ulnar border exceeds the metacarpo-dorsal surface (as partly formed by thumb) by nearly three fourths. The same is the case where the thumb is excluded from calculation, but the difference is greater, the metacarpo-ulnar border being more than twice as sensitive as the metacarpo-dorsal surface.

Comparison of the digital borders with the digital surfaces (palmar and dorsal).—The digito-radial border exceeds in sensibility the digito-palmar surface by nearly one fourth. It exceeds the digito-dorsal surface by three fifths.

The digito-ulnar border exceeds the digito-palmar surface by rather more than one eleventh. It exceeds the digito-dorsal surface by about three sevenths.

II. We may now proceed a step further, and see how the sensibility of the hand, as a whole, increases from the base to the distal extremity. In this inquiry we will exclude

the thumb, which may be made the subject of a separate examination.

Sensibility of zones formed by corresponding anatomical parts on both surfaces and borders of hand from base to distal extremity.

Zone.	Number of spots.	Mean Sensibility.	Excess over previous zone.
1. At base of metacarpus	8	3·175 in.	
2. At middle of metacarpus	8	2·712 „	over ⅛th.
3. At heads of metacarpus	10	2·115 „	over ⅛th.
4. At clefts of fingers	10	1·547 „	over ⅓rd.
5. Between last and 1st phalangeal joints	10	1·325 „	about ⅛th.
6. At first phalangeal joints	10	1·145 „	under ⅛th.
7. At middle of 2nd phalanges	10	1·007 „	under ⅛th.
8. At 2nd phalangeal joints	10	·790 „	over ⅛th.
9. At middle of last phalanges	10	·680 „	about ⅛th.
Tips of fingers	4	·4 „	about ⅓rds.

In even a superficial glance at this table, it will appear that while there is an uninterrupted increase of sensibility in the hand from the base to the tip, there are two remarkable parts at which it increases more rapidly than at others. The necessity of imparting a high sensibility to the fingers leads to a rapid increase as they are approached, and this increase is most observable immediately the heads of the metacarpal bones are passed. The rapid increase of sensibility at this spot was not unnoticed by Weber, although he applied a rough test to it, and applied it only to the palmar surface. It is at the heads of the metacarpal bones that the fingers anatomically commence. We need, therefore, not to be astonished at this rapid increase of sensibility prior to the attainment of the cleft of the fingers. The next part, and that at which the most rapid increase in sensibility of all takes place, is in the distal half of the last phalanges. From the cleft of the fingers to this latter part the rate of increase in sensibility is tolerably regular, being only slightly greater than elsewhere as the second phalangeal joint is approached. Nature here appears to have studied to avoid any great increase on approaching parts of the hand exposed, when the

fist is closed, to collisions, viz., the heads of the metacarpal bones and the first phalangeal joints. We shall see that this is so when we compare transverse lines on the dorsal surface.

Sensibility of transverse lines formed by analogous anatomical parts on the palmar surface.—These lines, as those to be presently considered on the dorsal surface, form part of the zones just considered.

Line.	Number of spots.	Mean sensibility.	Excess over previous line.
1. At base of metacarpus	3	1·900 in.	
2. At middle of metacarpus	3	1·800 „	⅛th.
3. At heads of metacarpus	4	1·600 „	⅛th.
4. In crease opposite clefts of fingers	4	1·275 „	about ⅛th.
5. Between last and 1st phalangeal joints	4	1·200 „	⅛th.
6. In crease opposite 1st phalangeal joints	4	1·062 „	over ⅛th.
7. At middle of 2nd phalanges	4	·936 „	⅛th.
8. In crease opposite 2nd phalangeal joints	4	·800 „	about ⅛th.
9. Middle of last phalanges	4	·662 „	about ⅛th.
Tips of fingers	4	·4 „	about ⅓rds.

The base of the hand on the palmar surface commences with a comparatively high sensibility, so that in order to attain the maximum at the tip the rate of increase need not be considerable. On this surface it is seen, as with the zones we have just considered, that there is a remarkable increase in the rate of augmentation immediately on passing the heads of the metacarpal bones, followed by as remarkable a decrease. The rate increases again, however, as soon as the parts of the fingers are approached, the palmar surface of which is most employed for palpation, viz., after passing the middle of the second row of phalanges, and especially on approaching the highly sentient tips of the fingers.

Sensibility of transverse lines formed by analogous anatomical parts on the dorsal surface.—The spots examined in these lines correspond to those on the palmar surface, and enter into the formation of the zones above considered.

Line.	Number of spots.	Mean sensibility.	Excess over previous line.
1. At base of metacarpus	3	4·633 in.	
2. At middle of metacarpus	3	3·900 „	under $\frac{1}{5}$th.
3. At heads of metacarpus	4	3·025 „	about $\frac{2}{5}$ths.
4. Opposite clefts of fingers	4	2·012 „	about $\frac{1}{2}$.
5. Between last and 1st phalangeal joints	4	1·575 „	over $\frac{1}{4}$th.
6. At first phalangeal joints	4	1·343 „	about $\frac{1}{5}$th.
7. At middle of 2nd phalanges	4	1·181 „	about $\frac{1}{7}$th.
8. At 2nd phalangeal joints	4	·850 „	about $\frac{1}{3}$rd.
9. At middle of last phalanges	4	·750 „	over $\frac{1}{9}$th.

We meet here again with the rapid increase in sensibility after passing the heads of the metacarpal bones, and again on approaching the second phalangeal joints, immediately after passing which, on approaching the nail, the rate of increase drops.

Comparison of corresponding lines on palmar and dorsal surfaces, and of rate of increase of sensibility on these surfaces.—The difference in sensibility of the two surfaces at various distances from the base of the hand may be thus stated:

Line.	
1. At base of metacarpus, palmar surface exceeds dorsal in sensibility by	about $1\frac{1}{2}$ time.
2. At middle of metacarpus, ditto by	$\frac{1}{5}$th. „
3. Opposite heads of metacarpus, ditto by	about $\frac{1}{3}$rd. „
4. At clefts of fingers, ditto by	about $\frac{2}{5}$ths. „
5. Between last and 1st phalangeal joints, ditto by	about $\frac{1}{2}$. „
6. At 1st phalangeal joints, ditto by	a little over $\frac{1}{2}$th. „
7. At middle of 2nd phalanges, ditto by	a little under $\frac{1}{2}$th. „
8. At 2nd phalangeal joints, ditto by	$\frac{1}{2}$th. „
9. At middle of last phalanges, ditto by	under $\frac{1}{2}$th. „

From this it appears that the difference in sensibility, considerable at the base, where a high sensibility on the dorsum would be inconvenient, gradually lessens as the apex of the hand is approached, where it is important that the dorsum should be little less sensitive than the palmar surface. And in order to attain this similarity, when at the base the sensibility of the palmar and dorsal surfaces is so dissimilar, it is necessary that the rate of increase, band after band, along the dorsum shall be more rapid on the dorsum than on the palmar surface, which originally starts with a more acute sensitiveness. The difference in rate is most remarkable in the proximal bands, and again in the band from the middle of

second phalanges to the second phalangeal joints. In the third band, commencing at the heads of the metacarpal bones, the difference is especially worthy to be observed. On passing the second phalangeal joints the rate of increase is highest on the palmar surface, to provide for the high sensitiveness of the tips.

Comparison of lateral halves of the hand.—We have already seen that the radial border of the hand (as partly formed by the radial side of the thumb) exceeds the ulnar border in sensibility, but that the ulnar border is the more sensitive when the radial border is considered to be constituted by the interval between the first and second metacarpal bones. We shall now see that a similar arrangement prevails if we compare, not the borders only, but the borders and adjoining surfaces together.

Comparison of lateral halves generally, including thumb and palmar and dorsal surfaces of fingers only.—The division is assumed to be formed by a line drawn down between the third and fourth metacarpal bones.

Radial half of the hand, mean sensibility of 59 spots,	1·424.		
Ulnar „	„	43 „	1·447.

The difference, indeed, is very trifling, but what there is is in favour of the radial side.

Comparison of lateral halves generally, excluding thumb, but including palmar and dorsal surfaces of fingers only.—

Radial half of the hand, mean sensibility of 44 spots,	1·410.		
Ulnar „	„	43 „	1·447.

Regarded in this way, the difference is again very trifling, but rather greater than when the thumb is included in the calculation.

I. We may now proceed to examine the lateral halves of the palmar and dorsal surface respectively.

Comparison of the lateral halves on the palmar surface, excluding tips of fingers.—

1st. Including thumb.—

Radio-palmar half of hand, mean of 21 spots, 1·139.
Ulno- „ „ 16 „ 1·204.

Thus regarded, the sensibility of the radial half of the palmar surface exceeds that of the ulnar half, but only by a trifle (about one eighteenth).

2nd. Excluding thumb.—

Radio-palmar half of hand, mean of 16 spots, 1·146.
Ulno- „ „ 16 „ 1·204.

Regarded thus, too, the difference is still less, but what there is is in favour of the radial side.

Comparison of the lateral halves on the dorsal surface.—

1st. Including thumb.—

Radio-dorsal half of hand, mean of 25 spots, 1·889.
Ulno- „ „ 16 „ 1·948.

Here, again, the predominance of sensibility is (but still to a very trifling extent) in favour of the radial side.

2nd. Excluding thumb.—

Radio-dorsal half of hand, mean of 16 spots, 1·779.
Ulno- „ „ 16 „ 1·948.

Regarded thus, a similar relation exists, but (otherwise to the palmar surface) the difference is greater than when the thumb is admitted into the calculation; it amounts to somewhat over one eleventh.

The palmar and dorsal surfaces may be compared on the radial and ulnar sides respectively.

Comparison of the radio-palmar and radio-dorsal regions.—1st. Including the thumb.—The radio-palmar exceeds the radio-dorsal surface by something over three fifths.

2nd. Excluding the thumb.—It exceeds it by about four sevenths, rather less than the general average of excess of the whole palmar over the whole dorsal region (two thirds), excluding the thumb.

Comparison of the ulno-palmar and ulno-dorsal regions.—The palmar surface exceeds the dorsal here by close upon the average of the whole surfaces, viz., three fifths.

Comparison of lateral halves in the proximal (metacarpal) region.—

1st. Including the thumb.—

Metacarpo-radial region, mean of 25 spots, 2·037.
Metacarpo-ulnar „ „ 11 „ 2·518.

In the proximal region, then, including the thumb in the calculation, the sensibility being still in favour of the radial half, the excess of that half amounts to nearly one fourth.

2nd. Excluding thumb.—

Metacarpo-radial region, mean of 12 spots, 3·050.
Metacarpo-ulnar „ „ 11 „ 2·518.

Regarded in this way (taking the interval at first and second metacarpal bones as forming part of radial border), the ulnar half of metacarpal region is more sensitive than the radial, the excess amounting to somewhat over one fifth.

Comparison of lateral halves in the digital region.—This only includes the consideration of the digital borders of the hand and the palmar and dorsal surfaces of the fingers.

Digito-radial region, mean of 32 spots, 1·000.
Digito-ulnar „ „ 32 „ 1·079.

There is here, also, a difference in favour of the radial side, which is in excess of the ulnar in sensibility, but only to a trifling extent.

Whether, then, the thumb be included or excluded, the greatest difference between the sides, when the fingers are in apposition, is found in the metacarpal region.

Let us now inquire how the relations of the lateral halves of the hand stand in the proximal and distal parts of the palmar and dorsal surfaces respectively.

Comparison of the lateral halves of the metacarpal region on the palmar surface.—

1st. Including the thumb.—

Radio-metacarpo-palmar region, mean of 8 spots, 1·481.
Ulno- „ „ 4 „ 1·700.

In this comparison it appears that the radial portion of the palm of the hand, when the palmar surface of the thumb as far as the phalangeal joint is taken into the calculation, exceeds the ulnar by above one seventh.

2nd. Excluding thumb.—

Radio-metacarpo-palmar region, mean of 4 spots, 1·750.
Ulno- „ „ 4 „ 1·700.

In this view it appears that the part of the palm to the rear of the index and middle fingers is to a very trifling extent less sensitive than that in the rear of the little and ring fingers.

Comparison of the lateral halves of the metacarpal region on the dorsal surface.—

1st. Including thumb.—

Radio-metacarpo-dorsal region, mean of 12 spots, 2·679.
Ulno- „ „ 4 „ 3·850.

The radio-metacarpal region on the dorsum of the hand then exceeds the ulno-metacarpal region by about one half, the difference between the sides of the hand when the thumb is included being thus very strongly marked, much more marked on the dorsal than on the palmar region.

2nd. Excluding thumb.—

Radio-metacarpo-dorsal region, mean of 4 spots, 3·350.
Ulno- „ „ 4 „ 3·850.

In this view the difference is much less marked, the predominance of the radial side being only somewhat over one seventh.

Comparison of the radio-metacarpo-palmar with the radio-metacarpo-dorsal surface.—1st. Including thumb.—On this side of the hand, in the metacarpal region, the palmar exceeds the dorsal surface in sensibility by about four fifths.

2nd. Excluding thumb.—Thus considered, the palmar is almost twice as sensitive as the dorsal.

Comparison of the ulno-metacarpo-palmar with the ulno-metacarpo-dorsal surface.—On this side of the hand the metacarpo-palmar surface is about two and a quarter times as sensitive as the dorsal. The difference, then, of the palmar and dorsal surfaces in the proximal part of the hand, is most marked upon the ulnar side.

Comparison of the lateral halves of the palmar surface in the distal (digital) part of hand.—

Radio-digito-palmar surface (index and middle fingers), mean of 12 spots, ·945.
Ulno- „ (ring and little fingers) „ 12 „ 1·039.

The palmar surfaces of the index and middle fingers together thus exceed those of the little and ring fingers together by one tenth. So that, whereas in the metacarpo-palmar region of the hand (exclusive of the thumb), the sensibility preponderates, if at all, to the ulnar side, in the digito-palmar region it preponderates on the radial.

Comparison of the lateral halves of the dorsal surface in the distal (digital) part of the hand.—

Radio-digito-dorsal surface (index and middle fingers), mean of 12 spots, 1·256.
Ulno- „ (ring and little fingers) „ 12 „ 1·314.

On the dorsal surface of the fingers the difference in mean sensibility between the two radial and the two ulnar fingers is less than on the palmar surface.

Comparison of the radio-digito-palmar with the radio-digito-dorsal surface.—The palmar surface of the two radial fingers together exceeds in sensibility that of the dorsal by one third, a very much smaller difference than is found in the surfaces in the radio-metacarpal region.

Comparison of the ulno-digito-palmar with the ulno-digito-dorsal surface.—The palmar surface of the two radial fingers together exceeds in sensibility that of the dorsal by somewhat over one fourth, so that while the difference of the surface in sensitiveness is vastly less than in the metacarpal portion of the hand on the same side, it is also less than exists in the digital region of the radial side.

II. We may now examine more minutely how the lateral halves of the hand differ in sensibility as we proceed from base to apex; we can see, at the same time, the rate of increase of sensibility on the two sides. I again omit the thumb from calculation.

Comparison of lateral halves of zones formed by corresponding anatomical parts on both surfaces and borders of hand, from base to distal extremity.—

Zone.		Radial Side. Spcds.	Mean.	Increase.	Ulnar Side. Spcds.	Mean.	Increase.	Difference, excess of. Radial.	Ulnar.
1	Base of metacarpus	3	3·233	—	3	3·000	—	—	About $\frac{1}{10}$th. Trifling
2	Middle of ditto	3	2·600	Under $\frac{1}{4}$th.	3	2·566	Over $\frac{1}{3}$th.	—	
3	Heads of ditto	5	2·050	Ab-ut $\frac{2}{3}$ths.	5	2·200	About $\frac{1}{4}$th.	About $\frac{1}{10}$th.	—
4	Clefts of fingers	5	1·500	About $\frac{1}{2}$ths.	5	1·495	About $\frac{2}{3}$ths.	About $\frac{1}{10}$th.	—
5	Between last and 1st phalangeal joints	5	1·290	Under $\frac{1}{3}$th.	5	1·360	Over $\frac{1}{3}$th.	About $\frac{1}{10}$th.	—
6	1st phalangeal joints	5	1·115	Under $\frac{1}{3}$th.	5	1·175	Under $\frac{1}{3}$th.	About $\frac{1}{10}$th.	—
7	Middle of 2nd phalanges	5	·945	Over $\frac{1}{3}$th.	5	1·020	About $\frac{1}{4}$th.	Under $\frac{1}{10}$th.	—
8	2nd phalangeal joints	5	·760	Over $\frac{1}{4}$th.	5	·830	About $\frac{2}{3}$ths.	Under $\frac{1}{10}$th.	—
9	Middle of last phalanges	5	·650	Under $\frac{1}{3}$th.	5	·710	Over $\frac{1}{3}$th.	Under $\frac{1}{10}$th.	—

From this table it appears—1. As respects the difference in sensibility of the two sides of the hand in the several zones, that at the base of the metacarpus the excess is, on the whole, in favour of the ulnar side, but that this difference disappears on proceeding further along the metacarpus, until at the level of the heads of the metacarpal bones the difference is in favour of the radial side, and remains so throughout the remaining distal part of the hand. From this point, however, to the first phalangeal joints the difference becomes gradually less marked, but after this is considerably increased, lessening again, however, from the second phalanges towards the apex of the hand.

2. As respects the rate of increase of sensibility on the two sides, on proceeding towards the apex of the hand it appears that, on the whole, as the ulnar side commences with a higher sensitiveness than the radial, so that sensibility increases towards the apex at a less rapid rate.

Comparison of lateral halves of transverse lines formed by analogous anatomical parts on the palmar surface.

Line.		Radial Side. Spcds.	Mean.	Increase.	Ulnar Side. Spcds.	Mean.	Increase.	Difference, excess of. Radial.	Ulnar.
1	Base of metacarpus	1	2·000	—	1	1·800	—	—	$\frac{1}{10}$th.
2	Middle of ditto	1	1·900	$\frac{1}{10}$th.	1	1·700	$\frac{1}{10}$th.	—	Under $\frac{1}{10}$th.
3	Heads of ditto	2	1·450	About $\frac{2}{3}$ths.	2	1·650	Very trifling.	Under $\frac{1}{10}$th.	—
4	Clefts of fingers	2	1·250	Under $\frac{1}{4}$th.	2	1·300	Over $\frac{1}{10}$th.	Very trifling.	—
5	Between last and 1st phalangeal joints	2	1·150	Under $\frac{1}{10}$th.	2	1·250	Very trifling	Under $\frac{1}{10}$th.	—
6	1st phalangeal joints	2	1·025	Under $\frac{1}{10}$th.	2	1·100	Under $\frac{1}{10}$th.	Under $\frac{1}{10}$th.	—
7	Middle of 2nd phalanges	2	·887	Under $\frac{1}{10}$th.	2	1·025	About $\frac{1}{10}$th.	Under $\frac{1}{10}$th.	—
8	2nd phalangeal joints	2	·787	Over $\frac{1}{10}$th.	2	·862	Under $\frac{1}{10}$th.	Over $\frac{1}{10}$th.	—
9	Middle of last phalanges	2	·625	Over $\frac{1}{4}$th.	2	·700	Under $\frac{1}{10}$th.	Under $\frac{1}{10}$th.	—
	Tips of fingers	2	·375	$\frac{3}{5}$ths.	2	·425	About $\frac{1}{2}$ths.	Under $\frac{1}{10}$th.	—

1. Thus, on the whole, the relative distribution of the sensibility on the two sides corresponds with what we found when the lateral halves of the zone were compared, but at most parts the difference between the sides is more marked.

2. The greatest difference in the rate of increase of sensibility, on tracing it from base to apex, is seen in the zone which commences in the middle of the metacarpus and at first phalangeal joints. There is greater uniformity after these joints are passed.

Comparison of lateral halves of transverse lines formed by analogous anatomical parts on the dorsal surface.

Line.		Radial Side. Spots.	Mean.	Increase.	Ulnar Side. Spots.	Mean.	Increase.	Difference, excess of. Radial.	Ulnar.
1	Base of metacarpus .	1	4·100	—	1	5·000	—	About $\frac{1}{5}$ths.	—
2	Middle of ditto .	1	3·600	Under $\frac{1}{4}$th.	1	4·000	$\frac{1}{4}$th.	About $\frac{1}{9}$th.	—
3	Heads of ditto .	2	2·850	Over $\frac{1}{3}$th.	2	3·200	$\frac{1}{4}$th.	About $\frac{1}{9}$th.	—
4	Clefts of fingers .	2	1·900	$\frac{1}{2}$.	2	2·125	About $\frac{1}{2}$.	Under $\frac{1}{10}$th.	—
5	Between last and 1st phalangeal joints .	2	1·550	Over $\frac{1}{3}$rd.	2	1·600	Under $\frac{1}{3}$rd.	Very trifling	—
6	1st phalangeal joints	2	1·350	Over $\frac{1}{4}$th.	2	1·335	About $\frac{1}{12}$th.	Very trifling	—
7	Middle of 2nd phalanges	2	1·137	Under $\frac{1}{4}$th.	2	1·225	About $\frac{1}{11}$th.	About $\frac{1}{12}$th.	—
8	2nd phalangeal joints	2	·850	About $\frac{1}{3}$rd.	2	·850	Under $\frac{1}{100}$th.	None.	
9	Middle of last phalanges	2	·750	Under $\frac{1}{4}$th.	2	·750	Under $\frac{1}{10}$th.	None.	

1. On this surface it is to be observed, then, that where a difference between the two sides does exist, it is in favour of the radial side, but that after passing the clefts of the fingers there comes to be a very trifling difference observable, and on passing the middle of the second row of phalanges none at all, and this in a part of the digital region where on the palmar surface the difference is the most marked.

2. As regards the rate of increase on the two sides, but little difference is, on the whole, observable.

Comparison of the sensibility of the palmar and dorsal surfaces, on the radial and ulnar halves respectively, in the several transverse lines.

Radial Side.

Line.	
1. Base of metacarpus	Palmar surface is twice as sensitive as dorsal.
2. Middle of ditto	Palmar surface is nearly twice as sensitive as dorsal.
3. Heads of ditto	Ditto.
4. Clefts of fingers	Palmar surface exceeds dorsal by over $\frac{1}{3}$.
5. Between last and 1st phalangeal joints	Ditto over $\frac{1}{3}$rd.
6. 1st phalangeal joints	Ditto under $\frac{1}{3}$rd.
7. Middle of 2nd phalanges	Ditto over $\frac{1}{4}$th.
8. 2nd phalangeal joints	Ditto over $\frac{1}{4}$th.
9. Middle of last phalanges	Ditto $\frac{1}{4}$th.

Ulnar Side.

Line.	
1. Base of metacarpus	Palmar surface is nearly thrice as sensitive as dorsal.
2. Middle of ditto	Palmar surface is more than twice as sensitive as dorsal.
3. Heads of ditto	Palmar surface is nearly twice as sensitive as dorsal.
4. Clefts of fingers	Palmar surface exceeds dorsal by nearly $\frac{1}{2}$rds.
5. Between last and 1st phalangeal joints	Ditto over $\frac{1}{3}$th.
6. 1st phalangeal joints	Ditto over $\frac{1}{4}$th.
7. Middle of 2nd phalanges	Ditto under $\frac{1}{4}$th.
8. 2nd phalangeal joints	Palmar and dorsal surfaces nearly agree.
9. Middle of last phalanges	Palmar surface exceeds dorsal by $\frac{1}{12}$th.

Thus it appears that, until the clefts of the fingers are passed, the difference between the dorsal and palmar surfaces is much more marked on the ulnar than on the radial side, but that beyond this line the difference is less marked than on the radial side.

Comparison of the central with the lateral parts of the hand on the palmar and dorsal surfaces.—Generally this comparison may be thus stated (excluding thumb):

	Radial side, mean of	Centre, mean of	Ulnar side, mean of
Palmar surface	9 spots, 1·177	16 spots, 1·200	9 spots, 1·280
Dorsal ditto	9 „ 1·888	16 „ 2·037	9 „ 2·165

In this comparison, in the digital region the radial side is assumed to be formed by the surface of the index finger, the central by the middle and ring fingers, and the ulnar by the little finger. Thus compared, it appears that the sensibility on the palmar surface generally may be said to shade off from the radial to the ulnar side, the central part being intermediate in sensibility. On the dorsal surface the same is observed.

Comparison of the central and lateral parts in the metacarpal region on the palmar and dorsal surfaces.—

	Radial side, mean of	Centre, mean of	Ulnar side, mean of
Metacarpo-palmar surface	3 spots, 1·800	4 spots, 1·725	3 spots, 1·733
Metacarpo-dorsal ditto	3 „ 3·300	4 „ 4·025	3 „ 3·900

Thus it appears that—1. On the palmar surface (excluding the thumb) the highest sensibility in the metacarpal region is in the centre, and that proceeding from this towards the border the sensibility becomes lowered, but more so towards the radial than towards the ulnar side, which last differs, in fact, very little from the centre in sensibility.

2. On the dorsal aspect the converse is observed; the centre is here the least sensitive part, and the sensibility increases towards the borders, and more markedly towards the radial than towards the ulnar border.

3. As a result of all this, it further follows that the difference in sensibility of the palmar and dorsal surface in this region is greatest in the central part and least in the radial; thus—

The palmar surface exceeds the dorsal in the radial part by $\frac{1}{5}$ths.
" " central " $1\frac{1}{3}$rd.
" " ulnar " $1\frac{1}{4}$th.

Comparison of the central and lateral parts in the digital region on the palmar and dorsal surfaces.—

	Radial side, mean of		Centre, mean of		Ulnar side, mean of	
Digito-palmar surface	6 spots,	·866	12 spots,	1·025	6 spots,	1·054
Digito-dorsal ditto	6 "	1·183	12 "	1·375	6 "	1·298

Hence—1. On the palmar surface the sensibility is highest on the index finger, and shades off towards the ulnar side, becoming least on the little finger. It is worthy of remark that the amount of sensibility of the palmar surfaces of the middle and ring fingers is identical, not only generally, but over each anatomically analogous spot.

2. On the dorsal surface, as in the metacarpal region, the lowest sensibility is found in the centre, the highest (as on the palmar) over the index finger, and the next highest over the little finger. On this surface the two central fingers, however, do not agree so closely in sensibility, the ring finger on the dorsum being less sensitive than the middle finger, although this difference is mainly discoverable posteriorly to the first phalangeal joint.

3. Thus it happens that the palmar sensibility, highest upon the index finger and shading off towards the little finger, becomes intensified on both borders, but chiefly upon the radial; that after turning these borders it again rapidly becomes lowered, until it attains its minimum upon the dorsum of the ring finger.

4. The difference in sensibility between the palmar and dorsal surfaces is greatest on the index finger. The nearest approach to uniformity, however, is found upon the little finger, thus—

The palmar surface exceeds the dorsal on the index finger by over $\frac{1}{3}$rd.
" " central fingers by about $\frac{1}{5}$rd.
" " little finger by about $\frac{1}{8}$th.

Of the two central fingers the palmar surface exceeds the dorsal in the middle finger by less than one third, and on the ring finger by over one third.

Comparison of sensibility of central and lateral parts in transverse lines on the palmar surface.

RADIAL SIDE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1	2·0	
2. Middle of ditto	1	1·9	$\frac{1}{19}$th.
3. Heads of ditto	1	1·5	$\frac{1}{3}$rd.
4. Clefts of fingers (index)	1	1·2	$\frac{1}{4}$th.
5. Between last and 1st phalangeal joints	1	1·05	$\frac{1}{4}$th.
6. 1st phalangeal joints	1	·95	under $\frac{1}{4}$th.
7. Middle of 2nd phalanges	1	·775	" $\frac{1}{4}$th.
8. 2nd phalangeal joints	1	·675	over $\frac{1}{4}$th.
9. Middle of last phalanges	1	·55	under $\frac{1}{4}$th.
Tips of fingers	1	·35	" $\frac{1}{3}$rds.

CENTRE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1	1·9	
2. Middle of ditto	1	1·8	$\frac{1}{19}$th.
3. Heads of ditto	2	1·6	$\frac{1}{8}$th.
4. Clefts of fingers (middle and ring)	2	1·3	under $\frac{1}{4}$th.
5. Between last and 1st phalangeal joints	2	1·25	$\frac{1}{21}$th.
6. 1st phalangeal joints	2	1·1	under $\frac{1}{4}$th.
7. Middle of 2nd phalanges	2	1·0	$\frac{1}{10}$th.
8. 2nd phalangeal joints	2	·8	$\frac{1}{4}$th.
9. Middle of last phalanges	2	·7	$\frac{1}{4}$th.
Tips of fingers	2	·425	about $\frac{1}{3}$rds.

ULNAR SIDE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1 ...	1·8	
2. Middle of ditto	1 ...	1·7	$\frac{1}{17}$th.
3. Heads of ditto	1 ...	1·7	none.
4. Clefts of fingers (little)	1 ...	1·3	under $\frac{1}{3}$rd.
5. Between 1st and last phalangeal joints	1 ...	1·25	$\frac{1}{5}$th.
6. 1st phalangeal joints	1 ...	1·1	under $\frac{1}{10}$th.
7. Middle of 2nd phalanges	1 ...	1·05	very trifling.
8. 2nd phalangeal joints	1 ...	·925	under $\frac{1}{10}$th.
9. Middle of last phalanges	1 ...	·7	under $\frac{1}{3}$rd.
Tips of fingers	1 ...	·4	$\frac{3}{4}$ths.

The middle and ring fingers absolutely agree at each line.

1. At the two proximal lines, then, the sensibility is lowest in the parts corresponding to the index finger, increasing regularly to the ulnar side (the parts corresponding to the little finger), but from the heads of the metacarpal bones onwards towards the apex the predominance is on the radial, and it either gradually lessens towards the little finger or the lowered sensibility of the central finger is maintained unaltered on the little finger.

2. The increase takes place at the greatest rate in the index finger, and the parts where this greater rate is most perceptible are in the band succeeding the clefts of the fingers and that succeeding the first phalangeal joints.

Comparison of sensibility of central and lateral parts in transverse lines on the dorsal surface.

RADIAL SIDE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1 ...	4·1	
2. Middle of ditto	1 ...	3·6	under $\frac{1}{10}$th.
3. Heads of ditto	1 ...	2·2	about $\frac{1}{2}$rds.
4. Clefts of fingers	1 ...	1·7	under $\frac{1}{3}$rd.
5. Between last and 1st phalangeal joints	1 ...	1·45	over $\frac{1}{3}$th.
6. 1st phalangeal joints	1 ...	1·3	„ $\frac{1}{10}$th.
7. Middle of 2nd phalanges	1 ...	1·125	under $\frac{1}{10}$th.
8. 2nd phalangeal joints	1 ...	·8	„ $\frac{1}{5}$ths.
9. Middle of last phalanges	1 ...	·725	over $\frac{1}{10}$th.

CENTRE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1 ...	4·8	
2. Middle of ditto	1 ...	4·1	about $\frac{1}{7}$th.
3. Heads of ditto	2 ...	3·6	„ $\frac{1}{9}$th.
4. Clefts of fingers	2 ...	2·275	„ $\frac{1}{3}$ths.
5. Between last and 1st phalangeal joints	2 ...	1·7	„ $\frac{1}{3}$rd.
6. 1st phalangeal joints	2 ...	1·4	over $\frac{1}{10}$th.
7. Middle of 2nd phalanges	2 ...	1·2	$\frac{1}{7}$th.
8. 2nd phalangeal joints	2 ...	·9	$\frac{1}{3}$rd.
9. Middle of last phalanges	2 ...	·775	about $\frac{1}{10}$th.

ULNAR SIDE.

Line.	Spots.	Mean.	Increase.
1. Base of metacarpus	1 ...	5·0	
2. Middle of ditto	1 ...	4·0	$\frac{1}{4}$th.
3. Heads of ditto	1 ...	2·7	about $\frac{1}{2}$.
4. Clefts of fingers	1 ...	1·8	$\frac{1}{3}$.
5. Between last and 1st phalangeal joints	1 ...	1·45	under $\frac{1}{3}$th.
6. 1st phalangeal joints	1 ...	1·275	about $\frac{1}{10}$th.
7. Middle of 2nd phalanges	1 ...	1·2	„ $\frac{1}{20}$th.
8. 2nd phalangeal joints	1 ...	·8	$\frac{1}{3}$.
9. Middle of last phalanges	1 ...	·725	over $\frac{1}{10}$th.

On the dorsum the middle and ring fingers do not accurately correspond; the principal difference in favour of the middle finger is met with on the proximal side of the first phalangeal joints; beyond this the sensibility of the fingers nearly corresponds.

1. In all of these lines, then, the centre is the least sensitive part of the dorsum, with the solitary exception of the first, the spot of lowest sensibility of the whole hand being found to lie over the base of the fifth metacarpal bone. With a trifling exception, scarcely worth noticing, the sensibility of corresponding spots on the index and little fingers is either in favour of the index or no difference is perceptible at all.

2. The most rapid rate of increase is noticed on the little finger and the corresponding part of the metacarpal region; the least rapid on the index.

FINGERS.

I. Observations were made upon the four surfaces of each finger (their free portion) and upon their tips.

The mean sensibility of the four fingers, including their tips, is as follows:

Index finger,	mean of 24 spots,		·929.	in.
Middle	„	„ 23	„ 1·088	„
Ring	„	„ 23	„ 1·132	„
Little	„	„ 24	„ 1·037	„

The borders of the digital portion of hand being its most sensitive parts (except the tips), it is found that the fingers which lie at the borders are also the most sensitive fingers on the whole. The index, little, middle, and ring finger, is the order of sensibility. The index finger exceeds the little finger by over one ninth, the middle finger by over one sixth, and the ring finger by over one fifth.

Surfaces of fingers.—As respects the palmar and dorsal surfaces of the four fingers, all that is necessary has already been said. I have merely to refer to their radial and ulnar sides, and to compare these together, and also with the palmar and dorsal surfaces.

Radial sides of fingers.—Their mean sensibility is as follows:

Index finger,	mean of 6 spots,		·804.	in.
Middle	„	„ 5	„ ·960	„
Ring	„	„ 5	„ 1·065	„
Little	„	„ 5	„ 1·095	„

So that the radial sides of the fingers follow the same rule as the palmar surfaces, shading off in sensibility from the index, which is the most sensitive, to the little finger, whose radial side is the least sensitive. This side of the index exceeds the corresponding side of the middle finger by under one fifth, of the ring finger by under one third, of the little finger by over one third. These corresponding sides of the ring and little fingers differ little in sensibility.

Comparison of the radial sides of fingers with their palmar surfaces.—The radial sides of each of the two radial fingers (index and middle) exceed in sensibility their palmar surfaces. On the two other fingers the palmar surface exceeds the radial; thus—

The radial side of the	index finger	exceeds the palmar surface	by about $\frac{1}{15}$th.
„	„ middle finger	„	„ $\frac{1}{15}$th.
The palmar surface of the	ring finger	exceeds the radial side	by over $\frac{1}{15}$th.
„	„ little finger	„	„ a trifling amount.

The palmar surface and radial sides of the little finger are almost identical in sensibility.

Comparison of the radial sides of fingers with their dorsal surfaces.—On every finger the radial side is more sensitive than the dorsal surface, thus—

The radial side of the	index finger	exceeds the dorsal surface	by under	$\frac{1}{4}$.
„	middle „	„	„	$\frac{1}{5}$ths.
„	ring „	„	„	$\frac{1}{3}$rd.
„	little „	„	„ over	$\frac{1}{10}$th.

The radial side of each, then, approaches in character the dorsal surface more and more as the fingers lie nearer and nearer to the ulnar side of the hand; it comes very much nearer to it on the little finger than on any of the others.

Ulnar sides of the fingers.—Their mean sensibility is as follows:

Index finger,	mean of 5 spots,		·965	in.
Middle	„	„ 5	„ 1·140	„
Ring	„	„ 5	„ 1·120	„
Little	„	„ 6	„ ·908	„

The ulnar side of the little finger entering into the formation of the border of the hand, which it is important should possess considerable tactile sensibility, is seen here, then, to be the most sensitive of all the fingers on their ulnar side. Next to it in order stands the index, which is superlatively the organ of touch, being so commonly used for this purpose separately from the other fingers. The ulnar sides of the middle and ring fingers nearly agree, as they do on their palmar and dorsal aspects. The little finger on this side exceeds the index in sensibility by about one sixteenth, and the ring finger by under one third. The index finger exceeds the middle and ring fingers by over one sixth.

Comparison of the ulnar sides of the fingers with their palmar surfaces.—The little finger (forming part of border of hand) here stands alone, for as the radial side of the index finger exceeds its palmar surface in sensibility, so the ulnar

side of the little finger is more sensitive than its palmar surface. In all the other fingers the palmar surface exceeds in sensibility their ulnar side. Thus—

The palmar surface of index finger exceeds the ulnar side by over $\frac{1}{3}$th.
„ middle finger „ „ about $\frac{1}{3}$th.
„ ring finger „ „ over $\frac{1}{11}$th.
The ulnar side of the little finger exceeds the palmar surface by under $\frac{1}{5}$th.

Comparison of the ulnar sides of the fingers with their dorsal surfaces.—On each of the fingers the ulnar side is more sensitive than their dorsal surface. Thus—

The ulnar side of the index finger exceeds the dorsal surface by under $\frac{1}{3}$th.
„ middle finger „ „ about $\frac{1}{3}$th.
„ ring finger „ „ over $\frac{1}{4}$th.
„ little finger „ „ $\frac{1}{3}$rd.

The nearest approach to the character of the dorsal surface is met with, then, on the middle finger, and the greatest difference on the little finger.

Comparison of the radial and ulnar sides of each finger.—The little finger here stands alone. The importance of giving high sensibility to the border of the hand has caused a concentration of its sensibility upon its ulnar side, so that it is the only finger in which the sensibility of this side exceeds that of the radial. In all the others the radial exceeds the ulnar side. Thus—

The radial side of the index finger exceeds the ulnar side by $\frac{1}{3}$th.
„ middle finger „ „ under $\frac{1}{3}$th.
„ ring finger „ „ about $\frac{1}{3}$th.
The ulnar side of the little finger exceeds the radial side by over $\frac{1}{3}$th.

The little use which is made of the sides of the ring finger make their sensibility of but little importance. The radial and ulnar sides, then, differ very slightly, both being comparatively low in the scale of sensibility. The radial side of the little finger is of no importance at all compared with the side which enters into the formation of the border of the hand.

Sensibility of the interspaces of the fingers; comparison of opposing sides.—As a body sufficiently small may be placed between the fingers in any of the three interspaces, this relation must not be overlooked.

	Ulnar side of		Radial side of		Sum of means.
1st interspace.	Index finger	·965 ...	middle finger	·960	1·925.
2nd „	Middle „	1·140 ...	ring „	1·065	2·205.
3rd „	Ring „	1·120 ...	little „	1·095	2·215.

The second and third interspaces pretty nearly agree in sensibility. The first exceeds them by over one seventh. A body placed in the interval between the index and middle fingers, then, would be felt better than when placed between the other fingers. In each interval the opposing radial side of the fingers forming it is the more sensitive. In the first interspace, however, the two opposing sides nearly agree in sensibility.

Tips of fingers.—In my hand the sensibility of the tips of the fingers is as follows:

Index finger . ·35 in.
Middle „ . ·4 „
Ring „ . ·45 „
Little „ . ·4 „

Weber represents "the tip of the third finger" (? middle) as the most sensitive. Valentin gives the predominance to that of the index. In my own hand the index is unquestionably the most sensitive at the tip. In this it merely corresponds with the general character of the finger. It is the finger the extremity of which we most commonly and instinctively employ alone to determine the physical qualities of any substance to which the sense of touch is applicable. The lowest sensibility is seated at the tip of the ring finger, which, except in conjunction with the other fingers is rarely used for this purpose. The tip of the middle finger is commonly used in conjunction with that of the index, and a somewhat higher sensibility of the tip of the little finger appears to be imparted to it, as forming, as it were, the extremity of the border of the hand.

II. As with the hand at large, so with each finger, the sensibility gradually increases from the attachment of the

fingers towards their extremities. This also may in each finger be studied in zones, formed by anatomically analogous parts, and also upon each surface.

Sensibility of zones formed by corresponding parts of fingers, from their attachment to distal extremities. The numbers within parentheses indicate the corresponding zones in the tables given with respect to the hand at large:

INDEX.

Zones.		Mean of		Increase.
(4)	1. Clefts of fingers	3 spots,	1·336	
(5)	2. Between last and 1st phalangeal joint	4 „	1·225	about $\frac{1}{4}$th.
(6)	3. 1st phalangeal joint	4 „	1·062	over $\frac{1}{4}$th.
(7)	4. Middle of 2nd phalanx	4 „	·875	„ $\frac{1}{5}$th.
(8)	5. 2nd phalangeal joint	4 „	·693	„ $\frac{1}{4}$th.
(9)	6. Middle of last phalanx	4 „	·606	about $\frac{1}{7}$th.
	Tip		·350	„ $\frac{1}{2}$ths.

MIDDLE.

Zones.		Mean of		Increase.
(4)	1. Clefts of fingers	2 spots,	1·700	
(5)	2. Between last and 1st phalangeal joint	4 „	1·475	over $\frac{1}{4}$th.
(6)	3. 1st phalangeal joint	4 „	1·268	about $\frac{1}{5}$th.
(7)	4. Middle of 2nd phalanx	4 „	1·056	„ $\frac{1}{4}$th.
(8)	5. 2nd phalangeal joint	4 „	·843	„ $\frac{1}{4}$th.
(9)	6. Middle of last phalanx	4 „	·662	over $\frac{1}{4}$th.
	Tip		·400	about $\frac{1}{2}$ths.

RING.

Zones.		Mean of		Increase.
(4)	1. Clefts of fingers	2 spots,	1·875	
(5)	2. Between last and 1st phalangeal joint	4 „	1·557	over $\frac{1}{4}$th.
(6)	3. 1st phalangeal joint	4 „	1·300	under $\frac{1}{4}$th.
(7)	4. Middle of 2nd phalanx	4 „	1·106	over $\frac{1}{5}$th.
(8)	5. 2nd phalangeal joint	4 „	·843	under $\frac{1}{3}$rd.
(9)	6. Middle of last phalanx	4 „	·675	about $\frac{1}{4}$th.
	Tip		·450	$\frac{1}{2}$.

LITTLE.

Zones.		Mean of		Increase.
(4)	1. Clefts of fingers	3 spots,	1·408	
(5)	2. Between last and 1st phalangeal joint	4 „	1·350	very trifling.
(6)	3. 1st phalangeal joint	4 „	1·156	about $\frac{1}{5}$th.
(7)	4. Middle of 2nd phalanx	4 „	1·056	over $\frac{1}{4}$th.
(8)	5. 2nd phalangeal joint	4 „	·825	„ $\frac{1}{4}$th.
(9)	6. Middle of last phalanx	4 „	·681	„ $\frac{1}{5}$th.
	Tip		·400	under $\frac{1}{2}$ths.

The rapid increase from the middle of the last phalanges to the tips of the fingers is here most marked; it is greatest

in those fingers which have the highest sensibility at the extremity.

The order of most acute sensibility of the fingers at large, viz., index, little, middle, and ring, is observed to be pretty accurately preserved in each zone. Now and then, however, the little and middle fingers agree in sensibility, and in one zone the middle and ring fingers agree. At the middle of the last phalanges, however, a different order is assumed, apparently preparatory to the final distribution of sensibility to their extremities, the order being index, middle, ring, little.

Comparison of anatomically analogous spots on radial sides of fingers.

Lines.		INDEX.		MIDDLE.	
			Increase.		Increase.
(5)	2. Between clefts of fingers and 1st phalangeal joint	1·050		1·400	
(6)	3. 1st phalangeal joint	·825	about $\frac{1}{5}$ths.	1·175	under $\frac{1}{4}$th.
(7)	4. Middle of 2nd phalanx	·675	under $\frac{1}{4}$th.	·925	over $\frac{1}{4}$th.
(8)	5. 2nd phalangeal joint	·575	over $\frac{1}{6}$th.	·775	under $\frac{1}{5}$th.
(9)	6. Middle of last phalanx	·500	over $\frac{1}{9}$th.	·525	„ $\frac{1}{2}$.

Lines.		RING.		LITTLE.	
			Increase.		Increase.
(5)	2. Between clefts of fingers and 1st phalangeal joint	1·550		1·600	
(6)	3. 1st phalangeal joint	1·300	under $\frac{1}{4}$th.	1·250	about $\frac{1}{3}$ths.
(7)	4. Middle of phalanx	1·125	„ $\frac{1}{5}$th.	1·125	$\frac{1}{9}$th.
(8)	5. 2nd phalangeal joint	·775	„ $\frac{1}{3}$.	·850	about $\frac{1}{3}$rd.
(9)	6. Middle of last phalanx	·575	over $\frac{1}{3}$rd.	·650	under $\frac{1}{3}$rd.

Each corresponding spot, then, follows the general rule of gradation of sensitiveness from radial to ulnar side pretty accurately.

Comparison of anatomically analogous spots on the ulnar sides of the fingers.

Lines.		INDEX.		MIDDLE.	
			Increase.		Increase.
(5)	2. Between clefts of fingers and 1st phalangeal joint	1·350		1·600	
(6)	3. 1st phalangeal joint	1·175	over $\frac{1}{4}$th.	1·400	$\frac{1}{4}$th.
(7)	4. Middle of 2nd phalanx	·925	about $\frac{1}{5}$ths.	1·150	over $\frac{1}{4}$th.
(8)	5. 2nd phalangeal joint	·725	„ $\frac{1}{5}$ths.	·900	„ $\frac{1}{4}$th.
(9)	6. Middle of last phalanx	·650	over $\frac{1}{9}$th.	·650	„ $\frac{1}{3}$rd.

Lines.		Ring.	Increase.	Little.	Increase.
(5)	2. Between clefts of fingers and 1st phalangeal joint .	1·600		1·100	
(6)	3. 1st phalangeal joint .	1·400	$\frac{1}{4}$th.	1·000	$\frac{1}{10}$th.
(7)	4. Middle of 2nd phalanx .	1·050	$\frac{1}{3}$rd.	·850	over $\frac{1}{10}$th.
(8)	5. 2nd phalangeal joint .	·900	$\frac{1}{3}$th.	·725	„ $\frac{1}{10}$th.
(9)	6. Middle of last phalanx .	·650	over $\frac{1}{3}$rd.	·650	„ $\frac{1}{10}$th.

In these tables, while the general rule as to the order of sensitiveness of these surfaces generally holds good, the following points are worthy of observation:—1st. That in the two most distal spots the index and little fingers actually coincide, while in the more proximal the little exceeds the index in sensibility. 2nd. That in all the spots, with one trifling exception, the ring and middle fingers agree. 3rd. That in the last spot the fingers all agree in sensitiveness. This last point appears to be related to the shape of the extremity of the hand from the different lengths of the fingers, bringing the ulnar side of the last phalanx of the ring finger into the formation of the border or extremity of the hand.

Comparison of sides and surfaces of each finger at each zone, arranging the sides and surfaces at each zone in the order of sensitiveness.

Zones.

(5) 2. Between clefts of fingers and 1st phalangeal joints.

Index. Surfaces.		Excess over succeeding surface.	Middle. Surfaces.		Excess over succeeding surface.
Palmar	1·050	$\frac{1}{4}$ths.	Palmar	1·250	under $\frac{1}{4}$th.
Radial	1·050	$\frac{1}{4}$ths.	Radial	1·400	$\frac{1}{4}$th.
Ulnar	1·350	$\frac{1}{13}$th.	Ulnar	1·600	trifling.
Dorsal	1·450		Dorsal	1·650	

Ring. Surfaces.			Little. Surfaces.		
Palmar	1·250	under $\frac{1}{4}$th.	Ulnar	1·100	under $\frac{1}{4}$th.
Radial	1·550	trifling.	Palmar	1·250	„ $\frac{1}{4}$th.
Ulnar	1·600	over $\frac{1}{11}$th.	Dorsal	1·450	over $\frac{1}{10}$th.
Dorsal	1·750		Radial	1·600	

Zone.

(6) 3. 1st phalangeal joints.

Index. Surfaces.		Excess over succeeding surface.	Middle. Surfaces.		Excess over succeeding surface.
Radial	·825	over $\frac{1}{4}$th.	Palmar	1·100	trifling.
Palmar	·950	under $\frac{1}{4}$th.	Radial	1·175	under $\frac{1}{4}$th.
Ulnar	1·175	under $\frac{1}{4}$th.	Ulnar	1·400	
Dorsal	1·300		Dorsal	1·400	

Ring. Surfaces.			Little. Surfaces.		
Palmar	1·100	under $\frac{1}{4}$th.	Ulnar	1·000	$\frac{1}{10}$th.
Radial	1·300	$\frac{1}{12}$th.	Palmar	1·100	under $\frac{1}{4}$th.
Ulnar	1·400		Radial	1·250	trifling.
Dorsal	1·400		Dorsal	1·275	

Zone.

(7) 4. Middle of 2nd phalanges.

Index. Surfaces.		Excess over succeeding surface.	Middle. Surfaces.		Excess over succeeding surface.
Radial	·675	over $\frac{1}{4}$th.	Radial	·925	trifling.
Palmar	·775	under $\frac{1}{4}$th.	Palmar	1·000	over $\frac{1}{4}$th.
Ulnar	·925	over $\frac{1}{4}$th.	Ulnar	1·150	
Dorsal	1·125		Dorsal	1·150	

Ring. Surfaces.			Little. Surfaces.		
Palmar	1·000	trifling.	Ulnar	·850	under $\frac{1}{4}$th.
Ulnar	1·050	$\frac{1}{11}$th.	Palmar	1·050	$\frac{1}{11}$th.
Radial	1·125	$\frac{1}{8}$th.	Radial	1·125	over $\frac{1}{11}$th.
Dorsal	1·250		Dorsal	1·200	

Zone.

(8) 5. 2nd phalangeal joints.

Index. Surfaces.		Excess over succeeding surface.	Middle. Surfaces.		Excess over succeeding surface.
Radial	·575	over $\frac{1}{4}$th.	Radial	·775	trifling
Palmar	·675	about $\frac{1}{4}$th.	Palmar	·800	$\frac{1}{4}$th.
Ulnar	·725	over $\frac{1}{4}$th.	Ulnar	·900	
Dorsal	·800		Dorsal	·900	

Ring. Surfaces.			Little. Surfaces.		
Radial	·775	trifling.	Ulnar	·725	over $\frac{1}{10}$th.
Palmar	·800	$\frac{1}{4}$th.	Dorsal	·800	$\frac{1}{10}$th.
Ulnar	·900		Radial	·850	about $\frac{1}{11}$th.
Dorsal	·900		Palmar	·925	

Zone. (9) 6. Middle of last phalanges.

Index. Surfaces.		Excess over succeeding surface.	Middle. Surfaces.		Excess over succeeding surface.
Radial	·500	$\frac{1}{10}$th.	Radial	·525	$\frac{1}{10}$th.
Palmar	·550	over $\frac{1}{10}$th.	Ulnar	·650	$\frac{1}{10}$th.
Ulnar	·650	„ $\frac{1}{5}$th.	Palmar	·700	under $\frac{1}{10}$th.
Dorsal	·725		Dorsal	·775	
Ring.			**Little.**		
Radial	·575	over $\frac{1}{10}$th.	Ulnar	·650	
Ulnar	·650	$\frac{1}{10}$th.	Radial	·650	$\frac{1}{10}$th.
Palmar	·700	under $\frac{1}{5}$th.	Palmar	·700	trifling.
Dorsal	·775		Dorsal	·725	

But few remarks are needed with respect to the above table.—1. On the index finger in each zone, the order of sensibility on the surfaces is, radial, palmar, ulnar, and dorsal, the only exception being that in the proximal zone the radial and palmar surfaces coincide. 2. On the middle finger the superiority in sensibility of the radial side over the others is only observable from the first phalangeal joints onwards. When the radial side becomes the most sensitive, the palmar surface comes second in order, until arriving at the last zone, when the ulnar side takes precedence of it. In all but the proximal and distal zones the ulnar and dorsal surfaces coincide. This renders the high position of the ulnar in the last zone more remarkable. 3. On the ring finger it is still later that the radial side acquires pre-eminence, viz., at the penultimate zone. Until this happens the palmar stands highest, and subsequently second. Both on this finger and on the middle there appears a tendency for the ulnar side to rise in the scale; here too in the last zone, and also in the antepenultimate zone, it stands second, in the former being above the palmar, and in the latter above the radial. 4. On the little finger this predominance of the ulnar side is confirmed. It throughout takes the first rank. In the three proximal zones the palmar stands next to it, but in the last two it is either lowest in sensibility or is not far removed from the lowest. In the last zone the radial side, which

had previously stood lowest or next to the lowest in sensibility, rises to the second place, next to the ulnar. It is worthy of remark, first, than in every zone in each finger, with the exception of two on the little finger, the dorsal surface stands last and lowest in sensibility; and next, that at the last zones (middle of last phalanges) of every finger, except the index, the radial and ulnar sides are more sensitive than the palmar surface.

A study of the columns headed "Excess of sensibility over succeeding surface," will show how gradually any variation in the order of pre-eminence on proceeding from the base towards the tip is effected.

Thumb.

In the previous portions of this inquiry I have found it convenient, for the most part, to discard the thumb from my calculations, and this mainly on the ground of simplicity in my statements. It is incumbent upon me now to enter upon a separate consideration of this organ, peculiar in its anatomy, in its attachment to the carpus, and in its opposability to other portions of the hand. In doing this, however, it will be necessary to take again into consideration the sensibility of certain spots upon its surface which have already been considered in other relations.

Thumb as a whole.—Its general sensibility, including its metacarpal and free portions, may thus be stated;—Mean sensibility of 25 spots, 1·529 in.

If we regard the thumb as destitute of a metacarpal bone, and as framed upon three bones analogous to phalanges, we may compare this mean with that of the fingers (including metacarpo-phalangeal joints and tips), on which view it is represented as less sensitive than any of them.

The sensibility of—				Excess over that of thumb.
Index finger thus represented is, mean of	27	spots,	1·012 in.	over $\frac{1}{2}$.
Middle finger „	„	25	„ 1·205	under $\frac{1}{5}$ths.
Ring finger „	„	25	„ 1·254	over $\frac{1}{4}$th.
Little finger „	„	27	„ 1·133	„ $\frac{1}{3}$rd.

It will be observed that by thus including the metacarpo-phalangeal joints, the order of sensibility is the same as when they are excluded.

Surfaces, *from carpal attachment to extremity.—Palmar surface* (*excluding tip*).—Mean sensibility of 6 spots, 1·262 in.

This surface is comparable with the palmar surface of the other fingers, including their metacarpo-phalangeal joints. Thus—

		Excess over sensibility of thumb.
Index finger thus represented, mean of 7 spots,	·957 in.	under $\frac{1}{3}$rd.
Middle finger „ „ 7 „	1·107 .	„ $\frac{1}{4}$th.
Ring finger „ „ 7 „	1·107 .	„ $\frac{1}{4}$th.
Little finger „ „ 7 „	1·146 .	„ $\frac{1}{5}$th.

It is, therefore, lower in sensibility than the corresponding parts of any of the other fingers.

It will be observed that, thus including the metacarpo-phalangeal joints, the order of sensibility of the above four fingers is the same as when they are excluded.

Dorsal surface.—Mean sensibility of 6 spots, 1·741 in.

This surface is comparable with the dorsal surface of the other fingers, including their metacarpo-phalangeal joints. Thus—

		Excess of sensibility over that of thumb.
Index finger thus represented, mean of 7 spots,	1·328 in.	under $\frac{1}{3}$rd.
Middle finger „ „ 7 „	1·639 .	about $\frac{1}{10}$th.
Ring finger „ „ 7 „	1·746 .	none.
Little finger „ „ 7 „	1·421	under $\frac{1}{4}$th.

The dorsal surface of the thumb thus agrees very closely with the corresponding part of the ring finger, of the finger whose dorsal surface is least sensitive of the four.

Here, too, the inclusion of the metacarpo-phalangeal joints does not affect the order of sensibility of the four fingers.

Radial side.—Mean sensibility of 6 spots, 1·420 in.

This surface may be compared with the radial side of the index finger, including the metacarpo-phalangeal joint. Thus—

Index finger thus represented, mean of 7 spots, ·882; excess over sensibility of thumb, under $\frac{1}{3}$ths.

But to compare with the other fingers, the carpo-metacarpal joint of thumb must be excluded. Thus—

Thumb, mean sensibility of 5 spots, 1·185 in.

		Excess over sensibility of thumb.
Middle finger, mean of 5 spots,	·960 in.	under $\frac{1}{4}$th.
Ring finger „ 5 „	1·065 .	over $\frac{1}{10}$th.
Little finger „ 5 „	1·095 .	under $\frac{1}{10}$th.

In all these instances the radial side of the thumb is below the sensibility of the radial sides of the other fingers.

Ulnar side.—Mean sensibility of 6 spots, 1·858 in.

The surface may be compared with the ulnar side of the little finger, including its metacarpo-phalangeal joint. Thus:

Little finger thus represented, mean of 7 spots, ·964, nearly twice the sensibility of the thumb.

But to compare with the other fingers, the carpo-metacarpal joint of thumb must be excluded. Thus—

Thumb, mean sensibility of 5 spots, 1·500.

		Excess of sensibility over that of thumb.
Index finger, mean of 5 spots,	·965 in. .	under $\frac{1}{3}$rds.
Middle finger „ 5 „	1·140 .	„ $\frac{1}{3}$rd.
Little finger „ 5 „	1·120 .	„ $\frac{1}{3}$rd.

It thus is exceeded in sensibility by all the other fingers.

Comparison of the above surfaces among themselves.—The order of sensibility of the surfaces of the thumb, then, is, palmar surface, radial side, dorsal surface, and ulnar side. Thus—

The palmar surface exceeds the radial side in sensibility by over	$\frac{1}{3}$th.		
The radial side „	dorsal surface „	under	$\frac{1}{4}$th.
The dorsal surface „	ulnar side „	about	$\frac{1}{10}$th.

Metacarpal Portion.—Sensibility of the metacarpal portion, including metacarpo-phalangeal joint, mean of 12 spots, 2·200 in.

If we compare this with the first phalanges of the fingers, including in the latter their metacarpo-phalangeal joints and the first phalangeal joints, we find the following results:

					Excess of sensibility over thumb.
The above portion of the index finger, mean of		14	spots,	1·307 in.	over $\frac{1}{7}$th.
„	middle finger	„ 12	„	1·622 .	„ $\frac{1}{4}$th.
„	ring finger	„ 12	„	1·700 .	under $\frac{1}{4}$th.
„	little finger	„ 14	„	1·425 .	over $\frac{1}{5}$.

So that the excess of the analogous parts of the fingers over this portion of the thumb is considerable.

Comparison of the palmar surface of the metacarpal portion of the thumb with the palmar surface of the analogous parts of the fingers.—

Palmar surface of metacarpal portion of thumb, mean of 3 spots, 1·666 in.

Palmar surface of analogous part (1st phalangeal) of—					Excess over thumb.
Index finger, mean of		4	spots,	1·175 in. .	under $\frac{1}{3}$.
Middle finger	„	4	„	1·312 .	over $\frac{1}{4}$th.
Ring finger	„	4	„	1·312 .	„ $\frac{1}{4}$th.
Little finger	„	4	„	1·337 .	under $\frac{1}{4}$th.

So that in every finger this part exceeds the sensibility of the metacarpo-palmar surface of thumb. That it should do so is in accordance with the former being mostly free and the latter not free, and with the comparatively low sensibility of the adjoining part of the palm of the hand. It is less used for palpation than the fingers, only coming in contact with bodies which are grasped.

Comparison of dorsal surface of the metacarpal portion of the thumb with the dorsal surface of the analogous parts of the fingers.—

Dorsal surface of the metacarpal portion of thumb, mean of 3 spots, 2·200 in.

Dorsal surface of analogous part (1st phalangeal) of—					Excess over thumb.
Index finger, mean of		4	spots,	1·662 .	over $\frac{1}{3}$ths.
Middle finger	„	4	„	2·162 .	about $\frac{1}{10}$th.
Ring finger	„	4	„	2·325 .	nearly the same sensibility.
Little finger	„	4	„	1·806 .	over $\frac{1}{4}$th.

While, then, the sensibility of the dorsal surface of this part agrees nearly with that of the analogous part of the ring finger, it is considerably lower than that of the other fingers.

Comparison of the radial side of the metacarpal portion of the thumb with that of the analogous parts of the fingers.—

Radial side of metacarpal portion of thumb, mean of 3 spots, 2·066 in.

This may be compared with the index finger :—

Radial side of analogous (1st phalangeal) part of index finger, mean of 4 spots, 1·106; excess over thumb, over $\frac{1}{2}$ths.

But for comparison with the other fingers, the carpo-metacarpal joint must be excluded. Thus—

Radial side of metacarpal portion of thumb, mean of 2 spots, 1·800 in.

Radial side of analogous part of—					Excess of sensibility over thumb.
Middle finger, mean of		2	spots,	1·287 .	about $\frac{1}{4}$ths.
Ring finger	„	2	„	1·425 .	over $\frac{1}{4}$th.
Little finger	„	2	„	1·425 .	over $\frac{1}{4}$th.

So that the excess is here again considerably in favour of all the other fingers.

Comparison of the ulnar side of the metacarpal portion of the thumb with that of the analogous parts of the fingers.—

Ulnar side of metacarpal portion of thumb, mean of 3 spots, 2·766.

This may be compared with the little finger :

Ulnar side of analogous (1st phalangeal) part of little finger, mean of 4 spots, 1·131, or 2$\frac{1}{2}$ times that of thumb.

But for comparison with the other fingers, the carpo-metacarpal joint must be excluded. Thus—

Ulnar side of metacarpal portion of thumb, mean of 2 spots, 2·350 in.

Ulnar side of analogous (1st phalangeal) part of—					
Index finger, mean of		2	spots,	1·262;	excess over thumb, about $\frac{1}{3}$ths.
Middle finger	„	2	„	1·500	„ under $\frac{1}{3}$ths.
Ring finger	„	2	„	1·500	„ „ $\frac{1}{3}$ths.

The difference in favour of the fingers is greater here than on any other surface.

Comparison of surfaces of metacarpal portion of thumb with one another.—The order of sensitiveness is the same as in the thumb at large.

The palmar surface	exceeds the radial side in sensibility by	under $\frac{1}{4}$th.	
The radial side	„ dorsal surface	„	about $\frac{1}{3}$rd.
The dorsal surface	„ ulnar side	„	„ $\frac{1}{2}$ths.

FREE PORTION OF THUMB.—Mean sensibility, including tip, mean of thirteen spots, ·909 in.

This may be compared with that of analogous parts of fingers, all beyond first phalangeal joints:

					Excess over sensibility of thumb.
The above part of index finger,	mean of	13 spots,	·696	.	under $\frac{1}{3}$rd.
„ middle finger	„	13 „	·819	.	about $\frac{1}{4}$th.
„ ring finger	„	13 „	·842	.	„ $\frac{1}{5}$th.
„ little finger	„	13 „	·819	.	„ $\frac{1}{4}$th.

So that here, too, as in the metacarpal portion, the sensibility of the thumb is less than that of any of the fingers.

Comparison of the palmar surface of the free portion of the thumb with the palmar surface of the analogous portions of the fingers.—

Palmar surface of free portion of thumb, mean of 3 spots, ·858 in.

Palmar surface of analogous part (3 last zones) of—					
Index finger,	mean of	3 spots,	·666,	exceeds sensibility of thumb by about	$\frac{1}{3}$rd.
Middle finger	„	3 „	·833	„	a tride.
Ring finger	„	3 „	·833	„	„
Little finger	„	3 „	·891,	exceeded slightly by thumb.	

So that the palmar surface of this part of the thumb agrees pretty nearly with that of the last three fingers in their analogous parts, but is exceeded slightly by analogous part of index. On the whole, then, its sensibility is high.

Comparison of the dorsal surface of the free portion of the thumb with the dorsal surface of analogous portions of the fingers.—

Dorsal surface of free portion of thumb, mean of 3 spots, 1·183 in.

Dorsal surface of analogous part (3 last zones) of—					
Index finger,	mean of	3 spots,	·883,	exceeds thumb by about	$\frac{1}{3}$ths.
Middle finger	„	3 „	·941	„	over $\frac{1}{4}$th.
Ring finger	„	3 „	·975	„	about $\frac{1}{3}$ths.
Little finger	„	3 „	·908	„	under $\frac{1}{3}$rd.

The difference is here also, to some extent, in favour of the fingers.

Comparison of the radial side of the free portion of the thumb with the radial side of the analogous portions of the fingers.—

Radial side of free portion of thumb, mean of 3 spots, ·775 in.

Radial side of analogous part (3 last zones) of—					
Index finger,	mean of	3 spots,	·583,	exceeds thumb by about	$\frac{1}{3}$rd.
Middle finger	„	3 „	·741	„	trifling amount.
Ring finger	„	3 „	·825,	is exceeded by thumb by about	$\frac{1}{16}$th.
Little finger	„	3 „	·875	„	over $\frac{1}{4}$th.

The radial side of the free portion of the thumb thus possessing a high sensibility, stands next in rank to that of the middle finger in its analogous part, and above that of the ring and little fingers.

Comparison of the ulnar side of the free portion of the thumb with the ulnar side of the analogous portions of the fingers.—

Ulnar side of free portion of thumb, mean of 3 spots, ·950 in.

Ulnar side of analogous part (3 last zones) of—					
Index finger,	mean of	3 spots,	·766,	exceeds thumb by about	$\frac{1}{4}$th.
Middle finger	„	3 „	·900	„	$\frac{1}{19}$th.
Ring finger	„	3 „	·866	„	under $\frac{1}{11}$th.
Little finger	„	3 „	·741	„	about $\frac{1}{3}$ths.

The difference here, too, is in favour of the other fingers, but the ulnar side of the thumb is not far behind that of the middle finger in sensibility.

Comparison of the above surfaces of free portion of thumb among themselves.—In this portion of the thumb the order of sensibility of the surfaces is different from that on the metacarpal portion, and resembles that of the index and middle fingers. The radial side has the highest sensibility, and the other sides follow in the order, palmar surface, ulnar side, dorsal surface. Thus—

The radial side	exceeds the palmar surface in sensibility by	under $\frac{1}{4}$th.		
The palmar surface	„ ulnar side	„	„	$\frac{1}{4}$th.
The ulnar side	„ dorsal surface	„	„	$\frac{1}{4}$th.

So that the dorsal side is by far the least sensitive.

TIP OF THUMB.—This is less sensitive than the tip of any of the other fingers. It is ·525 in.

COMPARATIVE SENSIBILITY OF PROXIMAL AND DISTAL PARTS OF THUMB.—*Comparison of metacarpal and free portions.*—The free portion exceeds the metacarpal in sensibility. It is $2\frac{1}{3}$ times as sensitive. This is a much greater difference than exists between the corresponding parts of the other fingers. Thus—

The more distal part of index and middle fingers is not quite twice as sensitive as that which is analogous to the metacarpal portion of thumb.
The more distal part of ring finger is about twice as sensitive as that which is analogous to the metacarpal portion of thumb.
The more distal part of little finger exceeds the proximal part by $\frac{1}{4}$ths.

Comparison of palmar surfaces of metacarpal and free portions.—On the palmar surface the free portion is nearly twice as sensitive as the metacarpal. This is a greater difference than exists between corresponding parts of the other fingers. Thus—

The more distal part of index finger exceeds the part analogous to the metacarpal of thumb by under $\frac{1}{3}$ths; middle and ring finger, by about $\frac{1}{4}$ths; little finger, by $\frac{1}{5}$.

Comparison of dorsal surfaces of metacarpal and free portions.—On this surface, also, the free portion is nearly twice as sensitive as the metacarpal. Here the difference is mostly less than between corresponding parts of the other fingers. Thus—

The more distal part of index finger exceeds the part analogous to the metacarpal of thumb by about $\frac{1}{3}$ths.
The more distal part of middle finger is $2\frac{1}{4}$ times as sensitive as part analogous to the metacarpal of thumb; ring finger is about $2\frac{1}{3}$rd; little finger, about twice.

Comparison of radial sides of metacarpal and free portions.—Here the free portion is $2\frac{2}{3}$th times as sensitive as the metacarpal portion. This is a greater difference than exists between the corresponding parts of other fingers. Thus—

The more distal part of index finger is not quite twice as sensitive as that analogous to the metacarpal of thumb.
The more distal part of middle finger exceeds that analogous to the metacarpal of thumb by about $\frac{2}{3}$ths; ring finger, by $\frac{1}{3}$ths; little finger, by $\frac{1}{5}$ths.

Comparison of ulnar side of metacarpal and free portions.—On this side the free portion is nearly three times as sensitive as the metacarpal. No approach to this difference is noticeable between the corresponding parts of the other fingers. Thus—

The more distal part of index finger exceeds that analogous to the metacarpal of thumb by about $\frac{2}{3}$ths; middle finger, by $\frac{1}{3}$rds; ring finger, by $\frac{1}{3}$ths; little finger, by about $\frac{1}{4}$.

So, then, the greatest difference between the metacarpal and free portions of the thumb is found on the ulnar side, and the next greatest difference on the radial side. It is only on the dorsal surface that the difference is to a less extent than is found existing on the other fingers; for the most part it is much greater.

Comparison of zones, &c., from base to distal extremity of thumb.—The following table will enable me to represent this comparison. The surfaces in each zone are arranged in order of highest sensibility.

Zone.	Surface.		Excess over succeeding surface.	Excess over same surface in preceding zone.
1. Base of metacarpus	Palmar	2·000	$\frac{1}{4}$ths	—
	Radial	2·600	trifling	—
	Dorsal	2·700	$\frac{1}{3}$rd	—
	Ulnar	3·600	—	—
	Mean	2·725		
2. Middle of metacarpus	Palmar	1·700	$\frac{1}{10}$ths	over $\frac{1}{3}$th
	Radial	2·200	$\frac{1}{11}$ths	$\frac{2}{11}$ths
	Dorsal	2·200	.	under $\frac{1}{4}$th
	Ulnar	2·600	.	$\frac{1}{13}$ths
	Mean	2·175		

Exceeds previous zone by over $\frac{1}{4}$th.

Zone.	Surface.		Excess over succeeding surface.	Excess over same surface in preceding zone.
3. Head of metacarpus	Palmar	1·300	. . $\frac{1}{10}$th	. . $\frac{1}{10}$ths
	Radial	1·400	. . $\frac{2}{10}$ths	. . $\frac{2}{10}$ths
	Dorsal	2·000	. . $\frac{9}{10}$th	. . $\frac{1}{10}$th
	Ulnar	2·100	. . .	. under $\frac{1}{10}$th
	Mean	1·700		
Exceeds previous zone by under $\frac{2}{10}$ths.				
4. Middle of 1st phalanx	Palmar	1·000	. .	. . $\frac{4}{10}$ths
	Radial	1·000	. . $\frac{4}{10}$th	. . $\frac{2}{10}$ths
	Ulnar	1·250	. under $\frac{1}{10}$th	. over $\frac{1}{10}$th
	Dorsal	1·350	. . .	. under $\frac{1}{10}$
	Mean	1·250		
Exceeds previous zone by over $\frac{1}{3}$rd.				
5. Phalangeal joint	Radial	·725	. over $\frac{1}{10}$th	. over $\frac{1}{10}$d
	Palmar	·850	. under $\frac{1}{10}$th	. over $\frac{1}{10}$th
	Ulnar	·950	. over $\frac{1}{10}$th	. under $\frac{1}{10}$d
	Dorsal	1·200	. . .	. $\frac{2}{10}$ths
	Mean	·931		
Exceeds previous zone by over $\frac{1}{3}$rd.				
6. Middle of last phalanx	Radial	·600	. $\frac{1}{10}$th	. over $\frac{1}{10}$th
	Ulnar	·650	. under $\frac{1}{10}$th	. under $\frac{1}{10}$
	Palmar	·725	. over $\frac{1}{10}$rd	. over $\frac{1}{10}$th
	Dorsal	1·000	. . .	. $\frac{2}{10}$ths
	Mean	·743		
Exceeds previous zone by over $\frac{1}{4}$th.				

In the above table the rate of increase in sensibility is seen to be greatest after leaving the connected part of the thumb. The gradual increase in sensibility of each surface from the base to the last phalanx is readily traceable; and, as in a former table relating to the fingers, the steady increase by which, zone after zone, the ulnar side acquires its ultimate high position of sensibility, from being the least sensitive at the base, is easily seen. In other respects the table speaks for itself.

I must postpone to some future communication the consideration of the results obtained by the application of the compasses in the long axis of the hand and transversely to it. The numbers upon which any subsequent remarks will be founded, I have, however, thought it best to include in the table which constitutes the appendix to the present paper.

General Summary.

1. Expressed in inches and parts of an inch, the sensibility of the hand, as ascertained by Weber's method, is 1·384. The extremes are 5 in. and ·35 in. These numbers represent the sum of two measurements, one transverse and the other vertical.

2. The order of highest sensibility of the several surfaces and borders of the hand, as a whole, differs somewhat according as the thumb is included in the calculation or excluded. 1st. Including the thumb, the order is, distal extremity, radial border, ulnar border, palmar surface, dorsal surface. 2nd. Excluding the thumb, it is, distal extremity, palmar surface and ulnar border, radial border, dorsal surface.

3rd. The sensibility of the hand, and of all parts of the hand, increase, gradually, but at a varying rate, from the wrist to the extremity. This is seen when we compare the numbers expressing the mean sensibility of the metacarpal and digital portions of the hand and of their several surfaces and borders, or when we compare zone after zone of anatomically corresponding parts, proceeding from the base towards the extremity, or, lastly, when each finger is examined separately.

4. The surfaces and borders of the metacarpal and digital portions being examined separately, it appears—1st. In the metacarpal region—(*a*) including the thumb, the order of sensibility is, radial border, palmar surface, ulnar border, dorsal surface; (*b*) excluding the thumb, the order is, palmar surface, ulnar border, radial border, dorsal surface. 2nd. In the digital region the order is, radial border, ulnar border, palmar surface, dorsal surface.

5. Comparing successive zones formed by anatomically

corresponding parts, the sensibility is seen to vary from the lowest at the base of the metacarpus, represented by 3·175 in., to ·680 in. at the middle of the last phalanges. The rate of increase from zone to zone is not uniform, but is most rapid immediately beyond the heads of the metacarpal bones, at which part, in fact, the fingers commence, although for a short distance they are connected by soft tissues. But the most rapid increase of all takes place from the middle of the last phalanges to the tips of the fingers. The same general facts are observed when the surfaces and borders of the hand and the fingers are separately examined.

6. Comparing the sensibility of the palmar and dorsal surfaces at each zone, it appears that the greatest difference between them is met with at the base of the metacarpus, but that this difference lessens steadily zone after zone as the distal extremity is approached.

7. The radial half of the hand, generally, exceeds the ulnar somewhat in sensibility. This same relation is found to exist when the radial and ulnar halves of the palmar and dorsal surfaces are separately examined.

8. In the proximal (metacarpal) portion, whether the thumb be included in the calculation or not, the radial half exceeds the ulnar half in sensibility much more than is observed in the distal (digital) portion.

9. On the palmar aspect of the proximal portion—(*a*) if the thumb be included in the calculation, the difference in favour of the radial half is still observed, but it is less than the average difference when all the surfaces are considered; but if (*b*) the thumb be excluded, and only the part of the palm of the hand in the rear of the four fingers be examined, the difference of sensibility is rather in favour of the ulnar half.

10. The most marked difference in favour of the radial side is found upon the dorsum. It comes out most strongly when the thumb is included in the calculation.

11. In the metacarpal region the greatest difference by far between the palmar and dorsal surfaces is met with on the ulnar half of the hand.

12. In the distal (digital) portion of the hand the pre-eminence of the radial side in sensibility is not very great on the palmar surface, and it is very much less upon the dorsal.

13. The difference in sensibility between the palmar and dorsal surface on the radial half of the digital portion (index and middle fingers) is more marked than on the ulnar half (little and ring fingers). But on both halves the amount of difference is less than is found in the proximal (metacarpal) region.

14. Omitting the thumb from calculation, and comparing the sensibility of the lateral halves at each zone, it appears that at the very base of the hand the difference is in favour of a higher sensibility on the ulnar side, but that this lessens on proceeding towards the heads of the metacarpal bones, where, as in all succeeding zones, the radial side becomes the more sensitive. This difference at the base in favour of the ulnar half is found to be limited to the palmar surface, for on the dorsal surface, wherever a difference of the two halves exists, it is always in favour of the radial half. But there is no difference on the dorsal surface at and beyond the second phalangeal joints.

15. On the palmar surface of the hand generally it may be said that the sensibility predominating on the radial side shades off towards the ulnar, and the same may be said generally of the dorsal surface. But this rule, thus expressed in general terms, calls for modification as different parts of the hand are examined. Thus—

16. Again omitting the thumb in the metacarpo-palmar region, whatever difference there may be is in favour of the centre of the palm, and the sensibility lessens towards the sides, and especially towards the radial side. But in the metacarpo-dorsal region the converse of this is observed, for the centre is, on the whole, the least sensitive part, and the sensibility increases towards the sides, and especially towards the radial side.

17. But in the digito-palmar region the general rule hold good absolutely; the two central fingers (middle and

ring), however, agreeing completely in their sensibility. On the digito-dorsal surface the lowest sensibility is found upon the ring finger, and the highest upon the index, the middle finger being intermediate. It increases also upon the little finger, which stands in sensibility next in rank to the index.

18. On comparing the lateral and central parts of the hand in the several successive zones on the palmar aspect, it is found that in the two proximal zones the sensibility is lowest on the radial side (parts in rear of index finger), and increases towards the ulnar side, but that from the heads of the metacarpal bones onwards the sensibility in each zone is greatest on the index finger, and shades off towards the little finger. On the dorsal aspect, in the line of every zone the centre is the least sensitive part, with one exception, and that is the zone corresponding to the base of the metacarpus, where the spot of lowest sensibility (5 in.) found over the base of the fifth metacarpal bone.

19. The order of highest sensibility of the fingers, taken in the mean of each, is index, little, middle, ring. The mean sensibility of the index finger is ·929 in., and of the ring finger 1·132 in.

20. The superior sensitiveness of the index finger is apparent, whatever part or surface is compared with the corresponding part or surface of any other finger, with the exception of the ulnar side. The tip of the index finger is the most sensitive part of the hand—it is ·35 in.

21. The radial sides of the fingers, like the palmar surface, are less sensitive the further we go from the radial side of the hand. The ulnar side of the little finger is the most sensitive, and the sensibility is lower as we go further from the ulnar side of the hand; the exception to this is the index finger, whose ulnar side stands next in rank to that of the little finger.

22. The radial sides of all the fingers exceed their dorsal surfaces in sensibility, and on the index and middle fingers they are also more sensitive than the palmar.

23. The ulnar sides of all the fingers are more sensitive

than the dorsal surface, but only the ulnar side of the little finger is more so than the palmar surface.

24. On the little finger alone the ulnar side is more sensitive than the radial. In all the others it is the reverse.

25. The sensibility of adjoining sides of the fingers is such that any object would be felt better when placed in the interval between the index and middle fingers, than between any of the others.

26. The order of sensibility of the tips of the fingers, in my hand, is—index, middle and little, ring.

27. In each finger the most rapid increase in sensibility is met with after passing the middle of the second phalanx, but the most rapid increase of all is from the middle of the last phalanx to the tip of the finger.

28. The orders of sensibility of the fingers at large is observed to hold good for each zone examined; but at the middle of the last phalanges a somewhat different order is assumed, viz., index, middle, ring, little.

29. On comparing corresponding spots on the radial sides of the four fingers, the order of sensibility established for the whole of these sides holds good. The same observation, *mutatis mutandis*, holds good generally as to the ulnar side, but it is worthy of observation that on the two most distal spots the sensibility of the index and little fingers coincides; that in all the spots, with a trifling exception, the ring and middle fingers agree, and that in the last spot all the fingers possess the same amount of sensitiveness.

30. The order of sensitiveness of the several sides and surfaces of each finger is not the same at all parts of the finger, with the exception of the index. The order, however, is in no case suddenly changed; a gradual alteration can, in each instance, be established.

31. In estimating the sensibility of the thumb, and in comparing it with other parts of the hand, I have regarded it as a finger destitute of a metacarpal element. The whole organ, from the carpo-metacarpal articulation to the tip, has been regarded as the analogue of a finger from the meta-

carpo-phalangeal articulation onwards. The free portion of the thumb has been compared with the portion of the fingers from the second phalanges onwards.

32. The thumb is, on the whole, less sensitive than the least sensitive of the fingers. This observation is true also when the tip or any surface of the thumb is compared with the tip or any corresponding surface of the four fingers; the only modification requisite in this statement being that the dorsal surface of the thumb coincides in sensibility with the least sensitive dorsal surface of the fingers; *i. e.*, with that of the ring finger. It also holds good when the metacarpal and free portions are severally compared with the analogous parts of the fingers.

33. Taking the thumb as a whole, the order of sensibility of its surfaces is palmar, radial, dorsal, ulnar. The order is the same if we confine our observations to its proximal (metacarpal) element.

34. Taking the free portion of the thumb alone, the order of sensibility of its surface is radial, palmar, ulnar, dorsal; the last being far inferior to the other three.

35. Comparing the several surfaces of the free portion of the thumb with those of analogous parts of the four fingers, it appears that its dorsal and ulnar sides are, on the whole, of lower sensibility than the corresponding parts of the fingers; that the palmar surface is of comparatively high sensibility, being only slightly exceeded by that of the index finger, and that the radial surface stands next in rank to that of the middle finger.

36. The free portion of the thumb is more than twice as sensitive as its connected (metacarpal) portion. On the ulnar side the difference is most marked, the next greatest difference is found on the radial side.

Appendix.

Table showing the actual Tactile Sensibility of One Hundred and Forty-two Spots on the Right Hand of the Author as measured in two directions, with the sum of the measurements at each spot examined.

HAND.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
1.—*Palm* of hand (exclusive of elevation corresponding with muscles of thumb).				
Point corresponding with—				
—— base of 3rd and 4th metacarpal bones	·9	1·0	...	1·9
—— base of 2nd ditto	1·2	·8	...	2·0
—— base of 5th ditto	·9	·9	...	1·8
—— middle of 5th ditto	·9	·8	...	1·7
—— middle of interval between 3d and 4th metacarpal bones	·9	·9	...	1·8
—— middle of 2nd metacarpal bone	·9	1·0	...	1·9
—— 2nd metacarpo-phalangeal articulation in anterior transverse crease	·7	·8	...	1·5
—— 3rd ditto	·8	·8	...	1·6
—— 4th ditto	·8	·8	...	1·6
—— 5th ditto	·9	·8	...	1·7
Sum	8·9	8·5	...	17·5
Mean	·89	·86	...	1·75
2.—*Back of hand* (exclusive of metacarpal bone and muscles of thumb).				
Point corresponding with—				
—— base of 3rd and 4th metacarpal bones	2·8	1·8	2·0	4·8
—— base of 2nd ditto	2·5	1·5	1·6	4·1
—— base of 5th ditto	3·3	1·4	1·7	5·0
—— middle of 5th ditto	2·8	1·1	1·2	4·0
—— middle of interval between 3rd and 4th ditto	2·5	1·6	...	4·1
—— middle of 2nd ditto	2·2	1·4	...	3·6
—— 2nd metacarpo-phalangeal articulation	1·1	1·1	...	2·2
—— 3rd ditto	1·8	1·7	...	3·5
—— 4th ditto	2·0	1·7	...	3·7
—— 5th ditto	1·5	1·2	...	2·7
Sum	22·5	*	15·2	37·7
Mean	2·25	...	1·52	3·77

* Wherever a measurement has been made with the tape it is, in the adding up, assumed as the correct measurement.

THUMB.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
THUMB (including metacarpal portion and elevation on palm corresponding to adductor muscles).				
3.—Palmar surface.				
Point corresponding to middle of metacarpal bone (*i. e.* midway between point on outer side of metacarpal bone and middle of 2nd metacarpal bone)	1·0	·7	...	1·7
In crease corresponding to metacarpo-phalangeal joint	·8	·5	...	1·3
Point corresponding to middle of 1st phalanx	·65	·35	...	1·0
,, ,, phalangeal joint	·45	·4	...	·85
Midway between last and tip of thumb, middle of last phalanx	·4	·325	...	·725
Tip of thumb	·25	·275	...	·525
Sum	3·55	2·55	...	6·100
Mean	·591	·425	...	1·017
4.—Dorsal surface.				
Point corresponding to base of metacarpal bone	1·5	·9	1·2	2·7
,, ,, middle of ditto	1·1	1·0	1·1	2·2
,, ,, metacarpo-phalangeal joint	1·0	·8	1·0	2·0
,, ,, middle of 1st phalanx	·9	·45	...	1·35
,, ,, phalangeal joint	·7	·5	...	1·2
A little below nail	·55	·45	...	1·0
Sum	5·75	4·10	4·70	10·45
Mean	·958	...	·783	1·741
5.—Radial surface.				
Point corresponding to base of metacarpal bone	1·5	1·0	1·1	2·6
,, ,, middle of ditto	1·2	·8	1·0	2·2
,, ,, metacarpo-phalangeal joint	·85	·55	...	1·4
,, ,, middle of 1st phalanx	·65	·35	...	1·0
,, ,, phalangeal joint	·45	·275	...	·725
Side of nail corresponding to middle of last phalanx	·35	·25	...	·6
Sum	5·0	...	3·325	8·325
Mean	·833	...	·587	1·420

INDEX FINGER.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
THUMB (*continued*).				
6.—Ulnar surface.				
Point corresponding to base of metacarpal bone	2·3	1·3	...	3·6
,, ,, middle of ditto	1·4	1·2	...	2·6
,, ,, metacarpo-phalangeal joint	1·1	1·0	...	2·1
,, ,, middle of 1st phalanx	·8	·45	...	1·25
,, ,, phalangeal joint	·6	·35	...	·95
,, ,, middle of last phalanx	·4	·25	...	·65
Sum	6·6	4·55	...	11·15
Mean	1·1	·758	...	1·858
INDEX FINGER.				
7.—Palmar surface.				
Crease opposite cleft of fingers	·7	·5	...	1·2
Between last point and 1st phalangeal joint	·6	·45	...	1·05
1st phalangeal joint	·55	·4	...	·95
Middle of 2nd phalanx	·45	·325	...	·775
2nd phalangeal joint	·375	·3	...	·675
Middle of last phalanx	·3	·25	...	·55
Tip of finger	·15	·2	...	·35
Sum	3·125	2·425	...	5·550
Mean	·446	·346	...	·792
8.—Dorsal surface.				
Point opposite cleft of fingers	1·0	·7	...	1·7
Between last point and 1st phalangeal joint	·9	·55	...	1·45
1st phalangeal joint	·8	·5	...	1·3
Middle of 2nd phalanx	·7	·425	...	1·125
2nd phalangeal joint	·4	·4	...	·8
A little below nail	·4	·325	...	·725
Sum	4·2	2·900	...	7·100
Mean	·700	·483	...	1·183

MIDDLE FINGER.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
INDEX FINGER (*continued*).				
9.—*Radial surface* (forming part of outer margin of hand).				
Point corresponding to metacarpo-phalangeal articulation	·75	·6	..	1·35
" " cleft of fingers and crease on palmar surface	·75	·45	...	1·20
Between last point and 1st phalangeal joint	·65	·4	...	1·05
1st phalangeal joint	·55	·275	...	·825
Middle of 2nd phalanx	·45	·225	...	·675
2nd phalangeal joint	·375	·2	...	·575
Middle of last phalanx	·3	·2	...	·5
Sum	3·825	2·350	...	6·175
Mean	·546	·335	...	·882
10.—*Ulnar surface.*				
Midway between cleft of finger and phalangeal joint	·8	·55	—	1·35
1st phalangeal joint	·8	·375	—	1·175
Middle of 2nd phalanx	·6	·325	—	·925
2nd phalangeal joint	·45	·275	—	·725
Middle of last phalanx	·4	·25	—	·65
Sum	3·05	1·775	—	4·825
Mean	·610	·355	—	·965
MIDDLE FINGER.				
11.—*Palmar surface.*				
Crease corresponding to cleft of fingers	·8	·5	...	1·3
Midway between last point and 1st phalangeal joint	·75	·5	...	1·25
1st phalangeal joint	·65	·45	...	1·1
Middle of 2nd phalanx	·6	·4	...	1·0
2nd phalangeal joint	·45	·35	...	·8
Middle of last phalanx	·4	·3	...	·7
Tip of finger	·175	·225	...	·4
Sum	3·825	2·725	...	6·55
Mean	·546	·389	...	·935

RING FINGER.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
MIDDLE FINGER (*continued*).				
12.—*Dorsal surface.*				
Point corresponding to cleft of fingers	1·4	·7	...	2·1
Between last point and 1st phalangeal joint	1·1	·55	...	1·65
1st phalangeal joint	·9	·5	...	1·4
Middle of 2nd phalanx	·7	·45	...	1·15
2nd phalangeal joint	·45	·45	...	·9
A little below nail	·45	·325	...	·775
Sum	5·0	2·975	...	7·975
Mean	·833	·495	..	1·329
13.—*Radial side.*				
Midway between cleft of fingers and 1st phalangeal joint	·9	·5	...	1·4
1st phalangeal joint	·8	·375	...	1·175
Middle of 2nd phalanx	·6	·325	...	·925
2nd phalangeal joint	·5	·275	...	·775
Middle of last phalanx	·3	·225	...	·525
Sum	3·1	1·70	...	4·8
Mean	·624	·340	...	·960
14.—*Ulnar side.*				
Midway between cleft of fingers and 1st phalangeal joint	1·1	·5	...	1·6
1st phalangeal joint	1·0	·4	...	1·4
Middle of 2nd phalanx	·8	·35	...	1·15
2nd phalangeal joint	·6	·3	...	·9
Middle of last phalanx	·4	·25	...	·65
Sum	3·9	1·8	...	5·7
Mean	·780	·360	..	1·140
RING FINGER.				
15.—*Palmar surface.*				
Crease corresponding to cleft of fingers	·8	·5	...	1·3
Between last point and 1st phalangeal joint	·75	·5	...	1·25
1st phalangeal joint	·65	·45	...	1·1
Middle of 2nd phalanx	·6	·4	...	1·0
2nd phalangeal joint	·45	·35	...	·8
Middle of last phalanx	·4	·3	...	·7
Tip of finger	·2	·25	..	·45
Sum	3·85	2·75	...	6·60
Mean	·550	·392	...	·942

LITTLE FINGER.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
RING FINGER (*continued*).				
16.—*Dorsal surface.*				
Point corresponding to cleft of fingers	1·8	·65	...	2·45
Between last point and 1st phalangeal joint	1·2	·55	...	1·75
1st phalangeal joint	·9	·5	...	1·4
Middle of 2nd phalanx	·8	·45	...	1·25
2nd phalangeal joint	·5	·4	...	·9
A little below nail	·45	·325	...	·775
Sum	5·65	2·875	...	8·525
Mean	·941	·479	...	1·420
17.—*Radial side.*				
Midway between cleft of fingers and 1st phalangeal joint	1·0	·55	...	1·55
1st phalangeal joint	·9	·4	...	1·3
Middle of 2nd phalanx	·8	·325	...	1·125
2nd phalangeal joint	·5	·275	...	·775
Middle of last phalanx	·35	·225	...	·575
Sum	3·55	1·775	...	5·325
Mean	·710	·355	...	1·065
18.—*Ulnar side.*				
Midway between cleft of fingers and 1st phalangeal joint	1·1	·5	...	1·6
1st phalangeal joint	1·0	·4	...	1·4
Middle of 2nd phalanx	·7	·35	...	1·05
2nd phalangeal joint	·6	·3	...	·9
Middle of last phalanx	·4	·25	...	·65
Sum	3·8	1·8	...	5·6
Mean	·760	·360	...	1·120
LITTLE FINGER.				
19.—*Palmar surface.*				
Crease corresponding to cleft of fingers	·8	·5	...	1·3
Between last point and 1st phalangeal joint	·75	·5	...	1·25
1st phalangeal joint	·65	·45	...	1·1
Middle of 2nd phalanx	·65	·4	...	1·05
2nd phalangeal joint	·55	·375	...	·925
Middle of last phalanx	·4	·3	...	·7
Tip of finger	·175	·225	...	·4
Sum	3·975	2·75	...	6·725
Mean	·567	·392	...	·960

LITTLE FINGER.	Measurement in long axis.	Transverse measurement.	Transverse with tape.	Sum.
LITTLE FINGER (*continued*).				
20.—*Dorsal surface.*				
Point corresponding to cleft of fingers	1·3	·5	...	1·8
Between last point and 1st phalangeal joint	1·0	·45	...	1·45
1st phalangeal joint	·85	·425	...	1·275
Middle of 2nd phalanx	·8	·4	...	1·2
2nd phalangeal joint	·4	·4	...	·8
A little below nail	·4	·325	...	·725
Sum	4·75	2·5	...	7·25
Mean	·791	·416	...	1·208
21.—*Radial side.*				
Midway between cleft of fingers and 1st phalangeal joint	1·1	·5	...	1·6
1st phalangeal joint	·85	·4	...	1·25
Middle of 2nd phalanx	·8	·325	...	1·125
2nd phalangeal joint	·6	·25	...	·85
Middle of last phalanx	·425	·225	...	·65
Sum	3·775	1·7	...	5·475
Mean	·755	·340	...	1·095
22.—*Ulnar side* (forming inner margin of hand).				
Point corresponding to base of 5th metacarpal bone at side of hand	1·1	·8	1·1	2·2
" " middle of ditto	1·0	·7	1·0	2·0
" " 5th metacarpo-phalangeal joint	·8	·5	...	1·3
" " crease opposite cleft of fingers	·75	·375	...	1·125
Between last and 1st phalangeal joint	·75	·35	...	1·1
1st phalangeal joint	·7	·3	...	1·0
Middle of 2nd phalanx	·6	·25	...	·85
2nd phalangeal joint	·5	·225	..	·725
Middle of last phalanx	·45	·2	...	·65
Sum	6·65	...	4·20	10·95
Mean	·738	...	·477	1·216

DESCRIPTION OF PLATES IV AND V.

These plates (reduced from photographs) show the precise spots at which measurements of the sensibility of the hand were taken. The two lines forming each cross indicate the two directions of measurement. The number written against each cross is the sum of the two measurements.

Fig. 1.—Palmar surface of hand and fingers.
„ 2.—Dorsal „ „
„ 3.—Radial side of hand and fingers.
„ 4.—Ulnar „ „

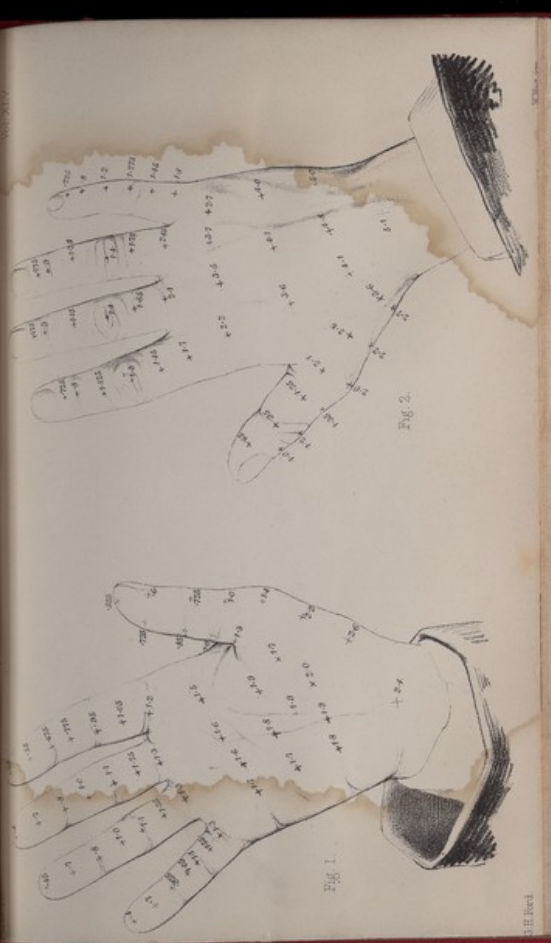

Fig. 2.

Fig. 1.

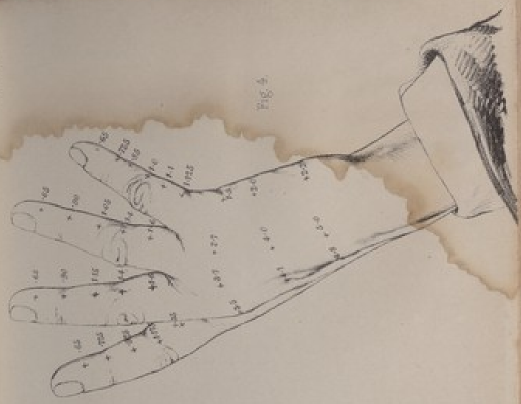

Fig. 4.

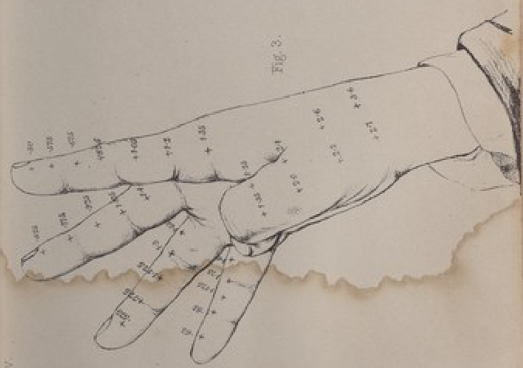

Fig. 3.

Plate V.

MANCHESTER STATISTICAL SOCIETY.

On the Value of Life Tables, National and Local, as evidence of Sanitary Condition.

By Henry Wyldbore Rumsey, F.R.C.S.

[Read November 14th, 1866.]

A.—The English Life Tables.

Almost all recent writers on the subject seem to agree in the opinion that a Life Table, representing the expected duration of life at birth, and at each succeeding year of age, in any nation, district, group or class of population, is the surest and safest test of its healthiness and vitality.

Without attempting even to sketch the history of these curious tables,* still less to discuss the mathematical methods of their construction, I wish to call attention to those recorded observations of life and death on which the tables are founded.

They are said to depend on two concurrent series of observations: the numbers and ages of the living, and the numbers and ages of the dying. Had these facts been always correctly observed and recorded, for a period long enough, and in a population sufficiently numerous and distinguishable from birth to death, to establish its

* For information on this subject, see Dr. Farr's writings in the Reports of the Registrar-General, especially in 5th and 6th Annual Reports; also Mr. Milne's article "Mortality" in the *Encyclopædia Britannica*.

own law of mortality, we might well accept the results as conclusive.

Dr. Farr, our highest authority on this subject, has, since 1841, constructed three Life Tables for England,—monuments of profound learning and immense industry.

In the first of these tables his calculations were reduced to a radix or scale of 100,000 infants under one year of age, consisting of boys and girls in the same proportion as those born and *registered* in the two years 1840-41. This constituted the hypothetical population which was to be traced through its successive annual decrements by death, until its final extinction in 100 or 105 years.

The deaths, male and female, out of this 100,000, in the first year, were assumed to be in exact proportion to the total deaths of each sex registered at that age in 1841. The births were assumed to have occurred in the year of which January 1, 1841, was the middle point. The survivors became the "population" from which the deaths registered as between one and two years of age in 1841 were again subtracted, in order to show the number of expected survivors on January 1, 1843.

For the first two years, therefore, the rate of mortality was not a *population* death-rate, but a *birth* death-rate. In fact, there was a dilemma. Had the radix of the table been taken to represent the census of population, instead of the register of births, the calculated ratio of mortality would have been higher; because a very large, though unascertained, number of the children living "under one year of age" had not been so enumerated; and the error would have been greater than that which has resulted from a comparison of deaths and births, not including those births which escaped registration. The unavoidable inaccuracy of the calculation, whether based on the Census or the Birth Registers, was frankly admitted by the author. A *true* basis being unattainable, the smaller error was wisely selected for the first two years of life; but for succeeding years—with the view of obtaining the probable survivors of the children born in 1840-41—it was thought better to adopt the census-distribution of the people according to ages,

and from it to estimate the proportion of the original 100,000, which was to constitute the hypothetical population living at each year of life; and it was again assumed that the males and females dying at each future year out of that hypothetical population would be in exact proportion to the total deaths of the respective sexes registered at such age in the single year of the Census.

After the first five years of life, the mortality was reckoned for quinquennial periods, and the precise ages of the people within each quinquennium were corrected by a process of interpolation. Some such adjustment was indeed necessary, for, in 1841, the Census Commissioners allowed persons of 32, 33, or 34, to call themselves 30, and so for other ages.

"Thus it was found that 6,633 men died at the age 20-25 out of 724,013 living; the mean age of those persons may be taken to be 22½ years; we know the mortality therefore at that age, and can tell (?) how many of a given number, say 32,792, aged 22, will live a year—how many of the survivors of the 100,000 alive on January 1, 1843, will be alive on January 1, 1864. By repeating this calculation at every quinquennial period of life, it becomes evident that the force of mortality is regulated by a law (?) and may be expressed by regular curves (?) which can be derived from, and enable us to correct, the observations, where they are known to be erroneous from mis-statements of age."*

The first doubtful assumption which strikes us in this remarkable passage is, that there is no evidence that the mean age of all persons living at any quinquennium or decennium of age is the precise age equidistant from the extremes, or that the majority of those persons might not be nearer one extreme than the other. We see numerous instances of aberration from a regular arithmetical progression, in different groups of population, and especially in the earlier years of life, and at periods of age chiefly affected by migration.

It is hardly necessary to say, that if, during any of the years of the quarter-century since 1841, a greater or a less proportion of the population than that "expected" did actually die at each

* Fifth Annual Report Registrar General, 1843, p. 22.

age, the hypothesis on which the first Life Table was formed is unsupported by facts. That table, I repeat, represented a series of estimates, regulated indeed by mathematical formulæ, but founded only on the facts of a single year, and on the particular composition and the vital forces of a pre-existent population. These "expectations" of life might or might not be realized in the actual duration of the lives of children born in 1840-41. Influences for good or for harm, exceptional disturbances of vital force—dearth, famine, and pestilence on the one hand, commercial prosperity and favourable seasons on the other—occurring as they have occurred in the after life-time of that generation, must have left a number of annual survivors differing more or less widely from the number expected to survive, according to the rate of mortality in 1841. Whether, in fact, the number, which ought by theory to have survived, did so survive, at the end of each succeeding year of life, can never be learnt; because it is impossible to trace the actual lives and deaths of the children represented by the fundamental 100,000 of the Table.

The objections naturally raised to an estimate of the duration of life in England—and with still greater force, as we shall see, to such estimates for towns and portions of the population—based solely on the rate of mortality for a single year, led to an extension of that basis in the second Life Table, which appeared in 12th Annual Report of the Registrar General. Here, the deaths occurring in seven years, 1838-1844, were taken as the data from which to calculate the mortality at each period of life,—the population of 1841 still remaining the pivot from which a hypothetical calculation was extended for the population in the three years preceding and the three following the year of enumeration. After the first 15 years of life, the rate of mortality in decennial periods was found to furnish "the most satisfactory basis for determining the series of fractions to express the probabilities of life"* at each year. Yet it can hardly be questioned

* Appendix, p. ii.; 12th Annual Report Registrar General.

that the longer the periods during which calculation is made to supersede observation, the greater is the risk of discrepancy between theory and fact.

The English Life Table, No. 3, has recently been published in a separate form.

This very important work being not so accessible as the reports of the Registrar General, and its author having been very explicit in his description of the principles and methods of its formation, I deem it advisable to repeat some of his definitions and introductory explanations, with occasional comments of my own. But I need hardly quote pages of symbols and equations which can interest few besides professional actuaries.

The new Life Table is calculated from the returns of two censuses, 1841 and 1851, and 6,470,720 deaths in 17 years—1838-1854.* Another ten years of observation is therefore added to the materials of the previous table, and the year 1846 is the middle of the term. This table, like its predecessors, is calculated from the *observed rates of mortality* at different ages in England and Wales. The rate of mortality expresses the relation between three elements:—(1) men living; (2) time; (3) men dying. The men living and the time expressed in years, multiplied into each other, produce the years of life with which the deaths are compared. A *year of life*, we are told, is the life-time unit, represented by one person living through a year, also by any number of persons living one at a time in continuous succession through a year. So also 525,949 persons, each living through one minute, are said "to enjoy one year of life." The years of life are determined by enumerating the population at certain periods of time, and thence deducing the numbers living through the time. Dr. Farr distinguishes the four following possible cases:—(1) the population is known or is assumed to be stationary; thus, a population of

* It has been assumed erroneously that this new table was based on the population of 1861. But the fact is, that *no* table founded on the last census has yet been published.

10,000 living for two years yields 20,000 years of life: (2) the population increases by equal numbers in equal times, *(i.e.)* in arithmetical progression; thus, if a population is 4,000 at the beginning and 6,000 at the end of a period, the mean, 5,000 will also be the population in the middle of the period, and multiplied by the intervening years will give the *years of life:* (3) if the population fluctuates much, and frequent enumerations are made, the mean of each successive couple of enumerations, multiplied by the time expressed in years and fractions of a year, will give nearly the years of life: (4) the population of a country naturally increases in equal proportions in equal times, or in geometrical progression, for this is the necessary result if the increase also increases; and if the increase be small, or if the mean of several terms be taken, the result differs little from the results under case 2.

In dealing with the English population determined for the middle of the years 1841 and 1851 from two enumerations, the population was carried back to the beginning of the year 1838, and forward to the end of the year 1854, by a mathematical process. "The years of life-time, enjoyed by males and females during the 17 years, were deduced (?) separately for each of twelve ages;" and this also by a series of equations and interpolations.

The true mean population in geometrical increase, is said to be *less* than the mean of the numbers living at the beginning and end, *more* than the number living in the middle of the period. Therefore, to divide the (average) annual deaths by the arithmetical mean of the extremes would understate the mortality, which varies inversely as the population. For the same reason, to divide by the population living in the middle of the period (if that could be ascertained) would overstate the death-rate. *The shorter the period, the less is the error.* The mean of the populations existing at two points of time (within the period) equidistant from the extremes—as 1841 and 1851—is near the true mean population living through the 17 years. Thus, in calculating the mean number of males of the age 15-25, it appeared that—

(a) 1,591,550=true mean *on the hypothesis* that the population increased in geometrical progression, at an uniform rate;

(b) 1,591,618=arithmetical mean of the numbers living in 1841 and 1851;

(c) 1,595,424=arithmetical mean of the numbers living at the beginning and end of the 17 years;

(d) 1,589,606=number living in the middle of the period.

After one stiff pull at the grammar of Life Tables, we may pause to take breath and courage for another, comforted by the assurance, which the preceding figures are intended to give us, that—in the present condition of our national statistics of life and death—the easily obtained arithmetical mean between any two consecutive decennial enumerations of a people expresses with sufficient accuracy its mean population for a longer period of years, the middle of which shall coincide with the middle of such decennium. But it is difficult to escape the inference, which again and again suggests itself—in reflecting on these methods of calculating probabilities of life—that an expenditure of much ingenious labour, and a risk of many questionable assumptions might be saved by counting up the population once a year. When we are advised, as in the preceding case 3, to take the mean of each successive couple of enumerations, if the intervals are *short*—or, as in the case of this Life Table, to take the mean of two enumerations equidistant from the extremes, if the period of observation be *long*—it is almost impossible to doubt that there is too much of theory, too little basis of fact, in the whole method of computation, and that we should be much safer and surer with an annual census, which would generally supersede the necessity of estimating a mean, or any intermediate stage, between two enumerations.

To return to Dr. Farr's preliminary explanations. The rate of mortality, we are again informed, is determined for the several periods of life by dividing the deaths registered at each age by the contemporaneous years of life out of which they occur, deduced

from the population of a corresponding age enumerated at the census.

Here, as in the previous Life Tables, it is assumed that the children born within the period of observation will live as long as, and no longer than, those who were born at intervals during the century preceding that period, and who made up the living population at the census. All the diverse conditions and circumstances — physical, moral, political, and social — which variously affected the duration of life in England for a long antecedent series of years (or the equivalents of those conditions), were assumed to exist and to act with precisely equal force upon the children born in 1838-1854 and constituting so large a portion of the present generation.

The new Life Table consists of three parts:—the first for "persons," and consisting of such proportions at each age of the two sexes as are produced by the births; the second for males; the third for females. The basis of part i. (for persons) is 1,000,000 children born alive; and as boys and girls were born in England during the period of observation in the proportion of 511,745 boys to 488,255 girls, these numbers were made respectively the bases of parts ii. and iii. In the synoptical table (p. 24) the numbers of males and females living and dying at each year of age are given, it is said, as they would exist in a population under the same law of birth and mortality, which is found by direct observation to prevail in England and Wales, *undisturbed by emigration, by excess of births over deaths, or by any other element of that kind.*

Now, as these conditions are never practically fulfilled in the English population, or in any portion of it, the hypothesis, however correctly applied to a calculation of probabilities, is of no practical value in the comparison of facts by the sanitary statist. It is, moreover, difficult to conceive how that which is here termed—the law of mortality, and which I should rather call—a series of calculated results from a limited record of events, can possibly be "undisturbed by emigration, by excess of births over deaths," &c.; for these certainly have always affected—though by no means

uniformly or according to any known law—the numbers, ages, births, and deaths of the English population; and their influences are unquestionable, if not calculable, upon every census and every mortuary register.

In addition to the principal computation of this great work, a vast amount of valuable information, arranged too in a convenient form for reference, is presented in a series of tables,—(e.g.) the mortality of males and females at different ages, the mean after-life-time, the mean age at death,*—and all these calculated for both sexes at all ages.

We learn that the expected duration of life at birth was 39·91 years for males, and 41·85 years for females, that the mean after-life-time of males and females at all ages was 32·1,—and that this would also be the "average age of the living" were the population stationary; but the excess of young people reduced the age of the nation to 26·4 in 1851—(*i.e.*) by 5·7 years, or *by half the difference between the mean age at death* 29·4 *and the mean expectation of life,* 40·9. The whole of that difference, 11·5 years, is said to be the result of the introduction of an excess of young lives; as, in addition to the 360,631 births to balance the deaths annually, 191,068 (making 571,699 children in the whole) were born annually and thrown upon the population.

Here, again, I must remark, that did the elementary facts, on which these tables are so beautifully calculated, deserve implicit confidence, the conclusions would be of the highest value. Dr. Farr himself confesses that, in a population which is disturbed by emigration, by immigration, by varying excesses of births over deaths, or of deaths over births, or by pestilence—and these are constant causes of disturbance in town populations—*the mean age of the dying can be determined only by the Registers.* This doubtless is

* The best definitions of these and other terms in use by writers on vital statistics, as the *vie moyenne*, the *vie probable*, the specific intensity of life, are to be found in the article "Vital Statistics" (before referred to) in the *Cyclopædia of Anatomy and Physiology.*

the true solution of the difficulty, and the true answer to a question which has been recently asked:—"Is there any numerical test "of the comparative salubrity of localities and the vitality of "different groups of population, which may be more correctly "employed than their respective rates of mortality?"

Before taking leave of Life Table No. 3, it may be as well to give, in a tabular form, the comparative Expectation of Life, from the THREE ENGLISH LIFE TABLES.

Expected Duration of Life by the English Tables.	Ages (Males.)							
	0	10	20	30	40	50	60	70
1841 .....No. 1.	40·17	47·08	39·88	33·13	26·57	20·03	13·59	8·62
1838-1844 ..No. 2.	40·36	47·47	39·99	33·21	26·46	19·87	13·60	8·55
1838-1854 ..No. 3.	39·91	47·05	39·48	32·76	26·06	19·54	13·53	8·45

The superiority of the new Life Table consists mainly in its embracing a considerably extended period of observation,—the elementary units being proportionately more numerous, and therefore the results less exceptional. This comparison shows that the probabilities of after-life-time at every age have decreased between 1841 and the last period of observation, the middle year of which was 1846. This decrease is greatest at the ages 20 ~~and 30~~ to 30, the most active and motive period of existence. We shall anxiously watch for a Fourth Life Table, extending the period of observation to 1864, with the census of 1851 at or about the middle point. If the late apparent fall of the vital barometer continues in England, notwithstanding "sanitary reform," we must cast about for some clue to the mystery.

B.—DISTRICT OR LOCAL LIFE TABLES.

I. If there are disagreeable uncertainties and probabilities of error in the records on which the English Life Tables are founded; if, owing to defective data, they are not perfect *indices* of the longevity of the English people; their fallacies shrink into insignificance when compared with those of similar calculations (also called Life Tables) for particular towns and districts.

In his 5th Annual Report, the Registrar-General published the elements of tables for the Metropolis, Surrey, and Liverpool; and, in the 7th, a more complete series for Manchester. A very clear idea of the comparative loss of life, from birth to the longest period of existence in each population, would be conveyed by some curiously constructed diagrams in the former volume, if the lives and deaths represented in each parallelogram really belonged to the community described. But wherever the movements of population from place to place are as free and unrestricted as they have now become between the various districts and towns of England, it is almost impossible to determine the specific intensity of life in any particular group of individuals; because the composition and colouring of each group is for ever shifting, as in a kaleidoscope. The same picture of the living and writhing mass is scarcely ever twice presented to the eye. The various degrees of reproductiveness in different portions of the population, and especially the continual migration of young adults from the rural districts to cities, cause extreme diversity in the proportions of the living and dying at almost every age. These oscillations of human life in different localities compensate each other to a great degree when the whole population of England is observed; but they stand out in full force when the facts recorded in each district are made the basis of a separate calculation.

A reference to the "birth-places" of the people in the Census will shew that very large, though very different, proportions of the great town populations were born in *other* counties of the kingdom. But, unfortunately, the census does not distinguish the natives of any provincial town from those of *its own* county. The *living* population of a place does not, therefore, in any way represent its *native* population. In like manner, the mortuary registers of all districts include deaths of persons who were born elsewhere. Multitudes die in the country who lived, if they were not born, in towns. The physiological and social differences which characterise the people of different districts—people begotten, born, bred, fed, and housed under every conceivable variety of circumstance,

condition, and hereditary influence—might indeed produce clear and distinctive results, for the use of the statist and the physician, if every such group could be traced from birth to death as a separate community; but since, in the course of life, the natives of probably every district are more or less dispersed, and are reckoned in the census, among other communities differing in various particulars from those of their extraction,—*no* local life-tables, constructed upon the census and registers in their present form, can represent truly—few, even approximately—the duration or expectation of life appertaining to the indigenous populations. For example, to show how differently the least fatal and most vigorous vicenniad of life—age 15 to 35—must affect a local life-table; it appears that in Liverpool the proportion of these young adults to the whole population, in 1841, was nearly 42 per cent.; in Manchester, 39·2; in London, nearly 40 per cent.* But in Surrey, it was only 34·3, and in 63 "healthy districts" (of which more hereafter) the proportion sank to less than 32 per cent.

We have seen that this difference, averaging 8 per cent. at that period of life, is caused mainly by the town influx of young and healthy people born in other districts. But to what extent this immigration affects the composition of town communities is only known exactly in London; for, although under "birth-places" in the census we can find how many of the inhabitants of each town and district were natives of other counties, the number born in healthy districts in the same county is not stated. Thus, we know not how far the population of Birmingham was recruited from Warwickshire, or how many inhabitants of Liverpool and Manchester sprang from a once stalwart ancestry in the agricultural districts of Lancashire. We may, however, be quite sure that the rates of mortality, recorded in the so-called Liverpool and Manchester Life Tables, for the adult and productive period of life, do not nearly represent the mortality of the native communities.

* In 1861, this rate had sunk to 36·1, approximating to the country ratio.

Again, the death-roll, on which a local life-table is founded, is as unreliable as its population element; for the continual exodus from country villages leaves the very young and the very old to die at home, while it credits other districts—populous towns especially—with the deaths of enterprizing emigrants.

II. There are 63 districts in England in which the reported mortality did not exceed 17 per 1,000. These, under the name of "the healthy districts" and formed into one group, have been employed by Dr. Farr as the population-basis of a new life-table, or rather series of tables, published in a scientific paper read before the Royal Society.* In this essay, the learned author minutely describes improved processes of interpolation and proposes some new formulæ. But our business is with the elementary facts of these tables, which, although founded on only five years of observation (1849-53) and one census (1851), are much less liable to exception, as far as population movements are concerned, than the life-tables of great towns. Nevertheless, on referring to the census of the ten selected districts of Sussex, it appears that nearly 24 per cent. of the adults were born out of that county; and, therefore, to that extent at least, the calculated duration of life is a doubtful index of the vital force of the Sussex people. Moreover, the reported mortality of these "healthy districts" does not show the deaths of their indigenous populations; for the natural increase resulting from the great excess of births over deaths has disappeared. It has been consumed in towns, and is reckoned in their mortality. The flower of the population has been sent to feed the furnace of life in manufacture and commerce. Under the First Napoleon, the young men of France were called *food for the cannon*. Under the present employments and movements and concentrations of the people of England, young men (and women too) of the rural districts are drafted off as—*food for the steam-engine;* and those who are spared by the factory and work-place are destroyed by the overcrowded dwelling, the impure air of the city, and the habits

* Philosophical Transactions, vol. 149, part II.

and vices of town life. Without a continual inpouring of country people at the healthiest ages, the great town-populations would rapidly waste away, by a natural or rather unnatural decrease.

Thus cursorily have I examined the grounds on which sanitary controversialists require us to adopt some numerical test of vital force and sanitary condition in a country, community or district,—whether that test be the ratio of deaths to population, or the ratio of deaths to births, or the ratio of births to population, or the average age at death*; or the expected duration of life and mean life-time, as shown in Life Tables. With inaccurate data, incomplete records of ill-defined facts, and other similar sources of error, these various methods (each and all) are open to valid objections. The same defects of data, which vitiate local rates of mortality, vitiate also the life tables deduced from them. The more complex and refined the calculations, the more offensively do the elementary errors obtrude themselves.

Generalization, an essential process in the induction of laws from numerous observations of facts and events, may be employed so rapidly, or on so insufficient a number of particulars, as rather to pervert truth than to aid in its discovery. It will be time enough to speak of the English laws of population and mortality, when the ultimate elements of calculation have been verified during long periods of observation. No series of equations, no logarithmic curves of mortality, no theoretical interpolations, will supply the want of full and accurate record of facts. We grant that facts are stubborn things, and apt to behave without the grace and complaisance of theories. Nevertheless, we had better accept them, in this matter, with all their faults,—verifying, correcting, and patiently accumulating the returns, until the mass of genuine material suffices for a profitable analysis and for a true induction of "laws" of life and death.

* These numerous tests are discussed in an article on "Vital Statistics, in the *Social Science Review*, August, 1866.

We ought to be enabled, by official records, to trace each life from its commencement to its conclusion,—connecting the registry of the birth with that of the death. The mortuary record ought to contain, as far as these particulars can be ascertained, the previous dwelling places of the deceased,—his class, profession or occupation, and civil condition,—beside the precise place of death and length of residence in that place before death.*

To conclude this part of my subject. Even under present circumstances, the Mean Age at Death of the natives of a district, town, county, or nation, would be a most valuable item of information; but, when supplemented and checked by the other particulars above-mentioned, it would be almost a perfect numerical test of the vital force and sanitary state of a given population. I am therefore justified in calling for at least one addition to every registry of death, namely, the birth-place of the deceased. This amendment might be immediately adopted. Others would follow. By degrees, and as the registration of births and deaths improves, and as sanitary organization advances, the number of birth-places "not specified" would steadily diminish; and from the commencement of the change there would be a respectable proportion of returns for purposes of calculation.

* It is most satisfactory to find that Dr. Farr, in his last official letter to the Registrar-General (27th Annual Report, pp. 176, 191)—a most interesting and important document—has sanctioned so large a portion of the recommendations which have been repeatedly urged by advocates of reform in the registration system.

REPORTS

ON EXPERIMENTS

WITH

CAPTAIN MccGWIRE'S

FIELD HAMMOCK.

PRINTED FOR PRIVATE CONVENIENCE, NOT FOR PUBLICATION.

LONDON:
A. NIMMO,
55, WIGMORE STREET, CAVENDISH SQUARE.
1866.

FIRST EXPERIMENT.

Camp, Fort Southwick,
July 5th, 1864.

SIR,

I HAVE the honour to forward for the favourable consideration of his Lordship, the Major General Commanding the District, and transmission to the Quarter Master General, the accompanying application of Captain MccGwire, of the Detachment under my Command, for a Board to report on the merits of a "FIELD HAMMOCK," invented by him;—and respectfully to add, that, having carefully inspected the Hammock, and personally tried it, as well as from the report of a Serjeant of the Detachment who had slept in one for several nights, it is in my opinion a most simple and practically useful invention, and would, I believe, if adopted in the Service, be of much benefit and comfort to both men and Officers in the Field.

I have the honour to be,
Sir,
Your Obedient Servant,
(Signed) F. G. URQUHART, Col.
and Major 2nd 1st Royal Regt.
Commanding Detachment.

To the Assistant Quarter Master General,
Portsmouth.

I beg to enclose the annexed letter and sketch of a Field Hammock, the invention of Captain MccGwire, 2nd 1st Royal Regiment, now under canvas on Portsdown Hill; having inspected this Hammock in a Tent, with a man in it, I think it has great advantages, and it keeps the man off the ground and at the same time

covers him; it is very light and portable, and in my opinion preferable to a "Tente d'abri."

(Signed) W. PAULET,
M. General,
Commanding S. W. District,
Portsmouth,
July 8, 1864.

The Currah Camp,
26th August, 1865.

SIR,

I have the honour to state with reference to Division Order, August 12, 1865, that two (2) Tents and twenty (20) Hammocks were handed over to the 1st 5th Fusiliers on the 15th instant, and were pitched and arranged under the directions of Captain MccGwire; the men were chosen from those who had been on Foreign Service, and 10 were told off to each Tent.

I beg to report that the weather has been very wet and stormy since the Tents and Hammocks have been under trial, that the men have slept in them regularly up to this date, and from questioning them individually, I find:—

1st. That they are all of opinion that the new Hammocks have a great advantage over the Field Blankets now in use.

2nd. That the Hammocks appear durable, and completely answer the purpose of keeping the men off the ground.

3rd. That the Hammock pegs do not give way with the weight of the men.

4th. That they prefer the Hammocks to sleeping on the ground, and find them particularly comfortable.

5th. That the Hammocks fold very easily on the Knapsack, and that the extra weight would be well compensated for by the extra comfort on arrival in Camp after a march.

I beg further to state that the opinion of the Officers of the Regiment agrees with my own, viz: that the Hammock is a most valuable invention, and likely to be of great advantage to the health and comfort of the Soldier on active Service.

I consider that each man should carry the Hammock complete, with the second cord and four pegs, so that it could be used if necessary, without the Tent, and in that way in wet weather would be preferred by the men to the usual Field Blankets even with the addition of a share of a tente d'abri; for example, it would be invaluable on an out-lying Picquet, and I have practised the men in putting up the Hammocks without as well as with the Tents.

I have found the comparative weights as follow, and it must be remembered that the Blanket would be more liable to wet from being on the ground, and after wet weather would be probably heavier.

	lbs.	ozs.
Captain MccGwire's Hammock . . .	5	6
2 Poles* . .	0	12¼
2 Ropes* . .	0	7½
4 Pegs . . .	0	15½
	7	9¼
Field Blanket . .	3	11
Tente d'abri complete, about 8 lbs. 4 ozs. Allowing to each 3 men ⅓	2	12
Total . . .	6	7

I have the honour to be,
Sir,
Your most obedient humble Servant,
(Signed) W. C. MASTER, Col.
Commanding 1st Bn. 5th Fusiliers.

The Brigade Major,
1st Brigade,
Curragh Camp.

---

* Or small staves or cords.

(Copy.)

P. M. O. Office,
Curragh Camp,
Sept. 15th, 1865.

Sir,

I am not aware whether the attention of the Director General has been called to the subject, but under any circumstances, I am justified in recording my opinion (among others) on the following points: — Captain MccGwire, Royal Regiment, has lately introduced a Field Hammock, which possesses so many advantages over the ordinary Field Blanket, that it is worthy of the consideration of the Medical Department of the Army, how far it is suited to supersede the latter on a campaign, or when Troops are tented in standing Camps, or for the use of the sick in Hospital Marquees.

A. The Field Hammock consists of Blanket Material much strengthened by a non-elastic and durable substance, thus combining warmth and strength.

B. It may be used either as a Blanket, or as a Hammock and covering, two-thirds of the width forming the Hammock, the remainder the covering.

C. It may be pitched either in a Tent, or in the open without Tents, so that the soldier has a bed at once ready for him, and carried by himself.

D. The Hammock complete consists of the Hammock proper, 2 staves (26 inches high), and 4 pegs and cords, the extra weight over the ordinary Field Blanket being under 3 lbs., while the whole can be quite as neatly folded on and fastened to the Knapsack.

E. The staves are made of the best red Deal, and though so light as not to weigh more than 5 ounces each, they are so strong, when placed at the angle necessary to sling the Hammock, that they are capable of bearing the weight of 3 men, each weighing 11 to 12 stone.

F. By increasing the radius of the ordinary Bell Tents 8 inches, ten men can readily be accommodated in each Tent. The Heads of the Hammocks (which are outwards) are 40 inches apart.

G. They can be put up in a very short time:—Thus, a Tent can be very readily pitched, the ten Hammocks slung, and their occupants all in bed in 8½ minutes.

From the above I submit that the advantages in a sanitary point of view, are simple and clear.

1. A Hammock is, under any circumstances, more comfortable than the ground, wet or dry.
2. The soldier carries his bed with him, and can pitch it anywhere under cover or not.
3. The Bed can be pitched in a few minutes.
4. The occupant is always off the ground.
5. The equal distribution, in either case, economizes space, and gives each man a clear berth.
6. The heads of the men are considerably raised above the draught from under the curtain of the Tent.

Three Tents, each containing 10 Hammocks, have for some time been in use here by the R. H. Artillery, 10th Hussars, and 5th Fusiliers. Those of the last-mentioned Regt. have slept there in all weathers, and have never suffered from damp or cold; indeed they have to myself personally expressed their sense of the comfort and snugness of the Hammock, as compared even with the Barrack Room Bed.

I am therefore of the opinion that Captain MccGwire's plan, being practicable, simple, and likely to be most serviceable, ought to have a more extended trial by authority, under various circumstances and different conditions.

I have the honour to be,
Sir,
Your most obedient Servant,
(Signed) W. ORD MACKENZIE, M.D.
Staff Surgeon Major,
P. M. O.

To the
Inspector General,
&c. &c. &c.
Army Medical Office,
Dublin Castle.

Army Medical Office,
Dublin Castle,
22nd Sept. 1865.

SIR,

Referring to your letter of the 15th instant, on the subject of a Field Hammock, lately introduced by Captain MccGwire, 2nd 1st Foot.

I have the honour to acquaint you, that I submitted your letter, with my recommendation for the consideration of the Director General, Army Medical Department, who suggests that you should bring the matter under the notice of the Local Military Authorities, who, on your recommendation, may be pleased to submit the Field Hammock to such full test as may establish its practical value.

You will be good enough to report the result of your representations, and also any further trial of the Field Hammock that may be made.

I have the honour to be,
Sir,
Your most obedient Servant,
(Signed) S. M. HADAWAY,
Inspector General.

The Principal Medical Officer,
Curragh Camp.

A true Copy.
J. MACGREGOR,
Dep. Ins. General,
Principal Medical Officer.

Principal Medical Officer's Office,
18th Nov. 1865.

P. M. O. Office,
Curragh Camp,
Sep. 26, 1865

SIR,

In forwarding the enclosed copy of a letter which I wrote to the Inspector General of Hospitals, in Dublin, on 15th inst.

I have the honour to state, he has recommended me, by instructions from the Director General, Army Medical Department, to bring the subject of it under the notice of the Military Authorities here. I have no doubt that the Major General Commanding the Division has already had his attention drawn to the Field Hammock, lately introduced by Captain MccGwire, Royal Regiment, and has probably formed his own opinion on its merits; at the same time, I consider it my duty as P. M. O. at this Station, to bring it more prominently before him, and to recommend that the Field Hammock be put to such full test as may establish its practical value.

To the full description and other remarks which I have made in the enclosed letter, I need only add, that, in reply to certain queries from me, the Medical Officers in charge of R. H. Artillery, 10th Hussars, and 5th Fusiliers, in which Regiments the Hammocks have been tested, in Camp, are all unanimous in favour of it.

I have the honour to be,
Sir,
Your most obedient Servant,
(Signed) W. ORD MACKENZIE, M.D.
Staff Surgeon Major,
P. M. O.

The A. A. General, &c. &c. Curragh.

A true Copy.
J. MACGREGOR,
Deputy Inspector General,
P. M. O.

P. M. O. Office, Curragh Camp,
Nov. 10, 1865.

Camp Curragh,
27th September, 1865.

SIR,

With reference to Memorandum dated "Assistant Quarter Master General's Office, 1st September 1865," I have the honour to report that an experimental Tent with ten Hammocks complete was received from Captain MccGwire on the 2nd instant, and ten old soldiers of the Regiment were detailed to occupy it, and have done so up to the present period.

I beg to state that I consider the Hammock a great improvement, being conducive to the health and comfort of the men, and the occupants of the Tent, who are old soldiers accustomed to Tent life in India and the Crimea, are unanimous in their approval of the Hammocks.

I have, &c. &c.

(Signed) V. BAKER, Colonel,
Commanding 10th R. Hussars.

To the Assistant Quarter Master General,
Curragh Camp.

Curragh Camp,
1st October, 1865.

SIR,

In returning the accompanying correspondence respecting the new Field Hammock, the invention of Captain MccGwire, 2nd 1st Regiment, I have the honour to report, that, in compliance with the instructions conveyed in your letter dated 13th July last, a trial of the invention has been given by different Corps in this Camp.

The Reports of the Officers commanding are enclosed, all of whom (with the exception of Colonel Holcombe, 2nd 1st Regiment) mention it in the highest terms of commendation.

I have also inspected the Hammocks, and I consider the invention excellent as a preservative to health on Field service.

The men who have used the Hammocks are unanimous in their praises of the comfort they have experienced when sleeping in them, etc. etc. etc.

(Signed) G. W. KEY,
Major General,
Commanding Dublin Division.

To the Deputy Quarter Master General,
Dublin Castle.

GERMINAL MATTER

AND THE

CONTACT THEORY.

BY

JAMES MORRIS, M.D. Lond.,

FELLOW OF UNIVERSITY COLLEGE.

LONDON:
JOHN CHURCHILL & SONS, NEW BURLINGTON STREET.

MDCCCLXVII.

GERMINAL MATTER

AND THE

CONTACT THEORY.

One sometimes reads of heaps of corn, in fertile and little accessible lands, rotting below while additions are being continually made above; medical literature bears too much resemblance to these accumulations. Facts and observations of the utmost value have been stored up in the archives of medicine in the past, and such are being added still; but matters of the utmost importance after being insisted on for awhile are lost sight of for long periods, and facts of equal importance are scarcely ever in equal prominence. The reason is that our facts are in great part isolated, and in numbers so vast that no human mind can firmly grasp them all. The evil is already great, and will assuredly increase unless the relation of the facts one to another can be detected, unless steps are made towards the discovery of the laws which bind the seemingly chaotic mass into the great plan of organic life, of which disease is part. Depreciation due only to baseless theories is too often extended to theory in general, but even a theory which does

no more than harmonise a large number of facts, is a useful aid to further progress, and is often the means by which we arrive at a law.

As a preliminary to the subject indicated by the above title, and in order to remove some obstacles out of our path, I must prove a medical theorem. We shall arrive at it by three easy steps. The first step is this:

I. Air floats with ease and for a considerable time and distance light and small masses of organic matter.

It can carry large and heavy ones.

Standing on the extreme edge of a river, a strong gale blowing over three hundred yards of water and wet mud, I have collected particles of quartz of considerable size which had struck me with stinging force on the face.

Volcanic dust and the sand of the African desert have fallen on ships far out of sight of land.

On a calm day, looking from a height at a dusty road crowded with foot passengers, you will see a cloud of fine dust, heavy particles, mostly silica, hanging over its whole course, and still more so if there are horses and wheels. The dust on the grass and hedges near roads and footpaths tells the same tale.

From a hill-top, when there is a gentle breeze and the air is clear, observe the smoke of a village trailing miles away; it will not be doubted that the smoke consists of solid particles.

Of all winds, the dry north-east, the polar current, carries with it most fine solid matter; it is colder, and, being therefore more dense, has greater floating power: it scarcely ever looks clear in town or country. Moisture, not in excess, aggregates and precipitates these particles and renders the air transparent.

On a still, hot summer afternoon it is a pleasure to watch the gossamer spider carried aloft on the fibres he has spun by the action of a current of air not strong enough to be perceptible to the hand.

Seeds of all sizes sail in the air, from the thistle or taraxacum, with their parachutes of bristles, down to the smallest floated by its thread of cotton. The spores of many fungi and the pollen of plants pass freely through the air, and can be collected on a glass wet with glycerine.

Odoriferous particles, tiny globules of essential oils, are borne immense distances. This is well and long known,

"As when to them who sail
Beyond the Cape of Hope, and now are past
Mozambic, off at sea north-east winds blow
Sabæan odours from the spicy shore
Of Araby the blest; with such delay
Well pleased they slack their course, and many a league
Cheered with the grateful smell old Ocean smiles."

II. Minute portions of organic matter are constantly thrown off by animals and men. This is our second step.

Unless it be from the teeth or nails, there would be difficulty in naming any surface of the body, internal or external, from which they are not, and this occurs especially in deviations from health, even though but slight. From the epidermis in its perfect condition there come only its dead scales, its sweat and sebum. But it is rarely in this condition over the whole body; a pimple broken sets free the pus cell; small spots of skin disease throw off the epithelium cells prematurely or discharge an ichor, which dries into the thinnest scales.

The mucous membrane in perfect health is said to form a hyaline mucus without even the mucus-corpuscle. This is almost an ideal state.

Very large surfaces may throw off their epithelium, as of the small intestine in cholera. Some say this is after death, and it may be after systemic death, but unless produced by putrefactive change like the peeling of the cuticle from a corpse, in which case it is of no importance, the tissues are not locally dead, or else it would not occur—a consideration unaccountably overlooked. In scarlatina, the kidney often desquamates as well as the skin. The conjunctiva in ophthalmia, the airways in coryza and bronchitis, the alimentary tract in diarrhœa, dysentery, &c.; the genito-urinary surfaces in cystitis, gonorrhœa, and syphilis; in fact, the whole inner skin throws off, according to the nature of the irritation to which it is exposed, its epithelium, the mucus-corpuscle and all its modifications, the pus-corpuscle, the compound granular corpuscle, nuclear or molecular matter, blood, and even small shreds of its own substance. The matters we

have spoken of in little pellets of mucus fall in the dust, dry exteriorly, and remain moist within, and with adherent fibres the *débris* of clothing, &c., must often bear no inconsiderable likeness to seeds or spores with the fibres attached, by which they are borne on the wind. Something similar will take place when dried on woven fabrics and broken off; or they may be thrown into the air in so minute a state of division as never to touch the ground till they reach their destination. Sneeze into a sunbeam penetrating a dark room, and you will see myriads of such particles, all containing organic matter, as small as the globules of mist or cloud. In the rooms of the sick, in forecastles of ships, in overcrowded houses, in the air surrounding thick habitations of men—especially where, as is far too often the case, urine and fæces are allowed to dry and rise in dust—particles of such organic matter are suspended in the air; they form part of it.

The third step is—

III. These are received into the body, and some pass into the lungs, so as to reach the blood.

They enter the eye, the mouth, the throat, the alimentary canal, and especially the airways, and to these I wish to direct particular attention. At this point I will crave my readers' pardon for asking them to call to mind the last London fog—how impossible it was to keep it out of their houses, how it made their eyes smart, was smelt in the nose, tasted in the mouth and throat, and felt far down into the lungs, and seen hours after in the expectoration—their doing so will

lend force to my argument. We will follow the air as it approaches the nostrils carrying with it all that it holds in suspension which, as we have seen, may not be little; it proceeds with increasing velocity as water to a sluice; and let me not be supposed to undervalue nature's means for preventing the entrance of impurities. The air, first strained through the hairs which protect the nostril without and within, next passes in a thin layer between moist surfaces sensitive both with olfactory and ordinary sense, then impinges on the back of the pharynx, and here the heavier particles, if not stopped before, are likely to be retained, to be eventually swallowed. Afterwards, it has to pass a portal guarded by the most acute sensation, the slightest irritation of which is sufficient to reverse the air-current. Once past the glottis, there are long tubes diminishing in calibre, their surfaces moist, and if even here, in the slackening stream, the particles touch and adhere, there are ciliæ ready to bring them in mucus to the glottis, to be expectorated or swallowed. Can anything escape so elaborate a respirator? The lungs of dry grinders and masons tell us too plainly that even particles of steel and silica large enough to feel gritty in the tissue of the lung, and to be easily found when that has been by heat or chemistry destroyed, may do so; and yet such particles are almost pebbles for weight and size compared to the little masses of surface-dry organic matter to which we have directed attention. These are in specific gravity so much lighter, and, while originally they may be of excessive minuteness, are further diminished by partial drying. In the act of inhalation we draw them far into the

lungs to surfaces wet with liquor sanguinis, to the very air-cells, that is, to the blood,

Sacratâ sistimus arce.

Three steps of proof lead to my theorem. They are—

1st. Air floats light little masses long and far.

2nd. We are always throwing off light little masses of matter.

3rd. These enter the body by different channels, especially by the airways, whose natural defences are insufficient to prevent them from going to the air-cells—to the blood.

My theorem, which follows as the inevitable conclusion, is,

That light little masses from the body of one individual are constantly received by other individuals so as to reach their blood.

This would be merely a disagreeable conclusion but of little moment, were it not that some of these matters are either living or contain living matter; and living matter, as we know—matter in a state of active growth—has the power of exciting living action similar to its own in suitable material. Before entering, however, on the subject of animal or human germinal matter, I wish to say a few words, in passing by the diseases in which vegetable organisms play an essential part. The skin, *oculis subjecta fidelibus*, affords a good opportunity of studying the relation of fungi to germinal matter; sometimes the germinal matter, lymph

or pus, appears first, and fungi are found in it; in other cases, Tinea for instance, as Dr. Tilbury Fox has shown, the fungi have the precedence by days or weeks. They have great difficulty in rooting on the healthy, but if we attribute ague to fungi or confervoid plants, like the palmellæ — its most probable cause—we must either give a very narrow definition of health, or admit that the healthy suffer. It would seem that the spores, as they exist in the most deadly malaria, grow, and that with great rapidity, on the membrane of the capillaries of the air-cell, passing from time to time into the blood. This theory of ague gets rid in great part of a puzzle of antiquity—the cause of the periodicity of ague, which is brought under the known laws of the periodicity of vegetable development. Some of those who discover an affinity (I think it imaginary) between ague and cholera will be inclined to attribute importance to M. Thomé's entophytes in the stools and bowels of cholera patients; but their alleged abundance raises a suspicion that they are something exceptional, good and painstaking observers having failed to find them before. Can we suppose a vegetable to flourish equally in the damp heat of the Lower Ganges, in the dry heat of Mecca, in the cold of St. Petersburg even in winter, in the salt air of the mid-Atlantic, and the saltless air of Central Europe? We know that the human body and vaccine (germinal matter) can do so. The ague is plant-like, *adscriptus glebæ*, and cholera a traveller, following with singular closeness lines of human intercourse: both are certainly diseases of season. It is generally true that in this climate cholera begins to increase with the first leaves and dies away with the

last; but I am inclined to attribute this to easier transmission of its poison, with unimpaired activity, in warmer water and air, and to the predisposition which the season brings. Catarrh has been attributed to vegetable organisms. We must first subtract all cases depending purely on cold, checked secretion, gouty or other diathesis, and perhaps also the severer epidemics which have affinities with typhus. These large deductions having been made, there is no reason to doubt vegetable influence, especially in spring catarrh. In May and June many tons of pollen alone are thrown into the air, and this is known in some individuals to cause the severe symptoms of hay asthma, and in others is no doubt the cause of slighter ones. The crust of ringworm may remind us that fungi and germinal matter may pass into the air together, and caution us against drawing hard lines.

It would seem that, among poisons, the more similar the constitution of the matter acting to that acted on, the more wonderful are the phenomena. No single dose of a poison from the mineral kingdom will produce even medicinal effect in a quantity less than about the fiftieth of a grain, nor from the vegetable kingdom in less than about the one hundredth of a grain, but animal poisons have an activity far beyond this; as examples, take inoculation and the poison of dissecting wounds. The poison of one species acts usually less or not at all on others, as we see in cattle plague affecting the sheep less, and the horse not at all. Rabies and glanders are exceptions. In the case of merely putrid matter there is not this difficulty as when putrid hides give malignant pustule. The most

fatal dissecting wounds are from recent human bodies after systemic death, but before complete tissue death, while germinal matter remains still living; not from the horribly putrid, and not from the bodies of animals. In the same individual where, of course, there is often a predisposition to similar action, we often see discharge containing germinal matter acting locally on neighbouring parts. I may cite as instances, the effect of the discharge of verrucæ, eczema, impetigo, and ecthyma, on surrounding skin; or the fact that in bedridden patients the expectoration of phthisis often marks its passage along the back of the windpipe by rows of ulcers, ceasing at the glottis. Or, to take an example from the interior of the body, the fact that an unhealthy wound, any kind of sore, will set up irritation or suppuration, that is, in other words, that germinal matter from the wound gives rise to the formation of similar germinal matter in the gland to which the lymphatics carry the lymph; and the lymphatic is not by purpose an excretory system, or it would not discharge into the thoracic duct.

But it is time that the name of Dr. Lionel Beale should appear in these pages; for to him we owe the outline of what I conceive to be a generalisation hereafter, probably, to rank as a landmark in medical science. We really had gone out of our way to make difficulties, to suppose poisons, strange mysterious entities, the investigation of which by microscope or chemistry was hopeless, when the actual poison was visible and tangible. Since I read—now a year and a half since—his remarks on purulent ophthalmia, gonorrhœa, and the contagious fevers, many previously

isolated facts have appeared to range themselves in connected order. What can be more reasonable than to attribute some of the most wonderful effects of disease to the most wonderful substance known—to "germinal matter"? In the case of vaccine, on this theory we would say that the living and growing part of the lymph is itself the poison; there is no other. When the ovum is syphilised through the semen, what reason is there to suppose that this semen differs from healthy semen in other manner than the semen of a consumptive, gouty, or rickety father differs from that of a healthy one? or, further, otherwise than that of a father with wavy hair from that of one with woolly? On reflection, it will be found that this amounts to no more than saying what we know from other sources to be true, that acquired peculiarities are transmitted to the offspring as well as hereditary ones.

Germinal matter is distinguished from "formed material," tissue which has completed its growth, by great power of absorption, by which it attracts nutritive matter to itself, and converts it into its own substance. Dr. Beale points out, as a sort of test for it, the readiness with which it takes up the colouring of cochineal, and of course other soluble matter also. I would remark, *obiter*, that I think he has here given us the clue to one of the modes of action of a large number of lotions, and of some internal medicines also. He showed, and this is of immense consequence, that such matter is capable of retaining its vitality under unfavorable circumstances for a long time, as, for example, the mucus and pus-corpuscle, the latter in weak tepid urine for forty-eight hours. He has also

shown pus living in the cell of vaginal epithelium. In order to explain the phenomena of, for example, cholera in this climate, we require on any theory to suppose that its poison can lie long dormant, and there are well-authenticated cases of infectious fevers breaking out a second time in houses, which make it necessary for any theory of them also to account for a period of dormancy; now, surface-dry germinal matter is almost in the condition of an egg or a seed. Many low forms of vegetation grow only when the air is moist, and when it is dry are dormant; infusoria, some of which resemble lumps of germinal matter, do so. Even a vertebrate animal, the mud-fish of the African rivers, passes the dry season moist in the midst of a cake of mud. I do not know if there be any evidence as to whether the snake-poisons are of the nature of germinal matter; if they are, one might refer to their extraordinary permanence. Dr. Christison found the poison of the cobra, dried into a mass like gum arabic, active after fifteen years; it is probable they are totally different, as is the case with the cantharidine and formic acid of the Spanish fly and the ant.

Many animal poisons remain dormant within the body before producing their systemic effect; more or less of local effect is probably produced at once. This period of incubation is very variable, from two or three days to very many months, as in the case of rabies. Syphilis has a very variable and sometimes very long period of incubation. The variability of this period, I submit, depends on the local conditions, in all cases the germinal matter producing general symptoms only when a considerable quantity of it has passed into the circulation.

Another period which is very variable is the duration of systemic action; and of this perhaps measles has the shortest, and syphilis the longest period. The latter disease, if no other, furnishes an instance of morbid germinal matter affecting continuously two generations.

The time during which a protective influence is exercised against the action of similar germinal matter is another period liable to variation, and most deserving of study. Since germinal matter can never want pabulum in the living body, it must exist in all the exanthemata, or recovery would not take place.

Survey the broad face of medical literature, and attempt to explain the facts there recorded without recognising the importance of this active living matter, its continual dispersion, its frequent reception, its occasional and varying activity, and the attempt will fail. You have catarrh sometimes going through a house, affecting new arrivals, or becoming an epidemic —influenza, sufficient to suspend public business, even prevailing so that scarcely an individual escapes, and not always with small mortality. Again, take the prevalence of boils, as was the case a few years ago, or of unnamed groups of anomalous symptoms, such as every physician knows that he and his brethren have met at the same time. Or take the typhus, typhoid, relapsing group of fevers, varying in intensity in different epidemics, from that of the Black Assizes, or the plague, to febricula. Take scarlatina, with its diphtheritic, ulcerative, and rheumatic variations; cholera shading off into rice-water purging, and so forth. But

it is needless to multiply instances; the anomalies are well known, the diseases which are not described, the diseases which are described, but which will not conform to the descriptions, or not long. How seldom is it acknowledged that the descriptions are but the descriptions of types, that round the umbra of each disease there is a broad penumbra continuous with that of other diseases, and that the succession of disease is not the succession of absolute identity, but merely of similarity, though tending to conform to certain types. But recognise the importance of germinal matter as pointed out by Dr. Lionel Beale, especially in his report on the cattle plague, and fresh light is thrown on pathology; recognise that the succession of this germinal matter need not be that of identity, but only of similarity, itself being descended from matter not having poisonous properties, or in slighter degree—that it is given off in all states short of an ideal health seldom if ever long maintained by men or animals—that its particles surface-dry can float in the air, are breathed frequently and much more frequently when the sanitary condition is bad,—make reasonable allowance for the influence of bearers, clothes, ships, or individuals, currents of water or air, and the difficulties in accounting for the transmission of the best marked types of disease disappear, and also the difficulties of new diseases, of varying types of old diseases, and of unclassified forms.

What is the range of activity of germinal matter? We have seen that it may act on the same individual by whom it is formed, as the discharge of verrucæ, the expectoration of phthisis, or the lymph of an unhealthy

wound; it may pass to a second individual by actual contact, as, say, gonorrhœal matter from the glands of the cervix-uteri to the urethral follicles; or chancre between genital mucous membrane and skin; or there may be a bearer intentional or accidental, as the vaccine point for the germinal matter of vaccinia, or water for that of cholera. I have insisted strongly on air as a bearer, because it has appeared to me that the difficulty of conceiving the transit through the air has been a stumbling-block to many. I have noticed the special power of the dry east wind to carry solid particles. Dr. Williams used to point out in his lectures the tendency of cholera to increase during these winds, and Sir Thomas Watson gives a marvellous example of the spread of influenza in such an atmosphere.

If particles were diffused into air equally from a point, their chance of being taken up by the mouth or nostrils would be as the square of the distance from the point. In a large hospital-ward with still air, two patients lying two yards and eight yards from a patient with typhus, the predisposition being equal, the nearer would be not four times, but sixteen times more likely to receive an effective dose of the poison. We see the influence of proximity on epidemics among animals and men; take of each a series of three: bees in hives, sheep in flocks, and animals scattered; a crowded ship, overpacked houses, and single dwellings; and are not the epidemics in rough proportion to the crowding?

Who that has watched from an eminence an ordinary grey mist settling in the calm air to the lower levels,

will be surprised that level is so important? There are some sources of fallacy but insufficient to vitiate the conclusion that the poison has a specific gravity greater than that of air; level has the same influence on the malarious poisons, which are certainly not animal germinal matter: and we have here the proof that neither of them are gases, or else by Dalton's law they would become equally diffused in the air.

The near coincidence of epidemics and epizootics, ever since the plagues of Egypt, shows that there are some circumstances which influence the production, activity, or durability of living germinal matter, and which, since the effect is seen on both animals and men, are not improbably of a meteorological nature. We have, I think, the means of throwing a light on this question, but the labour is too great for any individual.

Disease producing germinal matter may be reproduced by individuals who suffer little in the process, as we see in vaccinations, some inoculations, and in cholerine; just as among the truly parasitic diseases, a few trichinæ may be developed in a host without symptoms.

The more transmissible blood diseases of others can always enter our bodies by the air-passages. Here there is always liquor sanguinis exposed to the air, and ready to feed the floating particle which may develope in it; in vaccination, it is enough that the lymph touch a surface wet with liquor sanguinis; in both cases there is equally the connection from blood to blood

required by the contact theory. But a wound, a sore, the puerperal state exposes such a surface; and we find, as we should expect, that the precautions which sufficed when no other very inoculable surface was accessible except that so well protected in the lungs, are here insufficient, and if not increased the most lamentable results follow, and that from poisons which seldom affect the unwounded.

Dr. Beale supposes the infecting particles of germinal matter to pass solid into the blood, and probably to be covered with fibrine; in the case of scarlatina and erysipelas they can scarcely thus attain a size much larger than the white blood corpuscle, or the redness of the skin would not be so nearly uniform; while in variola it would seem that they become little emboli, which in the skin stick in the plexus surrounding follicles, the nuclei, as Mr. Erasmus Wilson points out, of the umbilicated pustule. In what other way is it possible to account for the form of the eruption? The experiments of Villemin lead to the same explanation of the arrangement of miliary tubercle, and of the scattered tubercles of the serous membranes. In some cases, might not the received germinal matter dissolve, communicating its properties to the liquor sanguinis? We see on the walls of a phagedænic ulcer lymph almost transparent, eroding solid skin with rapidity, and capable of transferring that action to healthy granulations.

It has been a question why variola by inoculation should as a rule be milder than by infection; the answer would seem to be, one is inoculated in a point or two of skin, the other in many air-cells. It is a puzzle

why sucklings so often escape, though they may go through, say, variola, in utero, and after weaning. The poison of the South African tsetse, which has some curious analogies with rabies, in its deferred effect, and in being apparently received from a species so different, seems not to affect calves; and I cannot find any account of an infant or a puppy affected with rabies.

Among the diseases of which we have spoken, in those whose course is more rapid it would appear that the active germinal matter produces but little formed material; or that what it does produce is not aggregated, but in the slower, as in some forms of tubercle and in cancer, cells play an important part. The relation of these diseases between themselves, as well as to typhoid fever, syphilis, farcy, and others, seems to me well worthy of study. I will not enter on the subject, but merely remark, as a caution against too absolute distinctions, that in some men whom we cannot call other than healthy, the irritation of a clay pipe to the lip, or of soot to the scrotum, will cause epithelial cancer, and that the secondary deposits may be scirrhus or medullary. What is that but the creation of cancer?

We see the creation of surgical fevers, hospital erysipelas, pyæmia and gangrene. The difficulty of preventing it is now well acknowledged; but can the best marked of contagious diseases, scarlatina, variola, or cholera, be so produced? It is certain that, if reproduced at all, it is under circumstances which fortunately are extremely rare. Looking at the extent to

which their type can vary, to the certainty that a very active and subtle poison is produced by the aggregation of healthy parturient women, and considering that the question presents itself on the germinal-matter theory in an entirely new aspect, that we are no longer in the difficulty of supposing a creation of living matter, but merely a change in the properties of existing germinal matter placed under new circumstances, it would at present be well to consider the matter open.

In conclusion, while it is good that we give ourselves to the study and observation of details—for without this there is no sound basis for general principles to rest on—it is also good that from time to time we take a more general survey of a wider field. The enunciation of the doctrine of germinal matter as an agent active in disease as well as in health, being of such importance that there is no branch of medical or surgical art on which it has not important bearings, furnishes a good opportunity for such a review. I have endeavoured to remove some objections to the doctrine, and to add here and there a stroke to its sketchy outline; with what success, the medical reader must judge.

May, 1867.

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With Dr. Stevenson's Compts.

Printed from the Guy's Hosp. Reports 1868.

NOTE

ON A CASE OF MELANURIA.

By THOMAS STEVENSON, M.D.

Though cases have been recorded by Golding Bird, Hughes, Odling, Petters, and others, in which black or dark brown urine was excreted, yet they are sufficiently rare to induce me to place the following on record.

About a couple of ounces of black urine was handed to me on October 19th, 1867, by Mr. Bryant's dresser. It had been passed shortly before death by a woman whose thigh had been amputated for an osteo-sarcomatous tumour. No abnormal pigmentary deposit was found in the tumour itself, nor in the body on post-mortem examination. The woman was supposed to have suffered from scarlatina subsequently to the operation; but the evidence of this was extremely doubtful. She had a distinct rash and soreness of the throat, accompanied with the passage of this dark urine; but it could not be determined whether the rash was scarlatinous or one of those eruptions which are not unfrequent in surgical wards after operations. No disease nor marked congestion of the kidneys was observed. The patient had had the stump dressed with a solution of carbolic acid; and it is a singular circumstance that in nearly all cases in which true black urine has been passed, either wood- or coal-tar creosote—both of which contain carbolic

acid or closely allied bodies—has been administered either externally or internally.

This urine was of a black colour, and when in thin layers it was brownish black—not unlike a mixture of Indian ink and water. On standing it let fall a black deposit, in appearance very like the deposit which forms in ordinary inkstands. The liquid was almost perfectly clear, alkaline in reaction (doubtless from decomposition which had set in), and its sp. gr. was 1·0189. The colour was not separable by filtration through the finest Swedish filter paper. This, coupled with the circumstance that some, though not much, of the colouring matter was deposited on long standing, shows that this was in a state of extremely minute division, but not in true solution. The urine became faintly opalescent on heating, but again resumed its almost perfect clearness on the addition of nitric acid, at the same time acquiring a faint but decided purple tinge. Equal parts of this and of normal urine of the same density were separately evaporated to dryness, incinerated, the ashes dissolved in dilute nitric acid, filtered through paper free from iron, and the filtrates tested with a solution of potassic sulphocyanate. Both liquids assumed a pink tinge from the production of ferric sulphocyanate, and the depth of colour was nearly the same in both, being, if anything, slightly greater in that from the normal than that from the pathological urine. The elements of blood (albumen and hæmatine) were thus excluded, and it became evident that the cause of the singular colour must be sought in some other direction.

Most, if not all, specimens of black urine hitherto examined have contained indigo-blue, or some body possessed of similar chemical and physical properties; such as insolubility in water, alcohol, ether, and the neutral solvents generally, and solubility (with chemical change) in alkalies in presence of a reducing agent. Indigo-blue is likewise soluble in concentrated sulphuric acid, and the solution presents a characteristic absorption spectrum when viewed through the micro-spectroscope. Indigo has thus been recognised in a case of skin disease by Dr. W. Frank Smith,[1] of Sheffield. I may here state that indigo, or an indigo producing body, is, according to

[1] 'Journ. of Cutan. Med.,' vol. i, p. 54.

the best observers, a normal constituent of urine. The presence of indigo-blue in the urine of those suffering from melanuria has all the more interest from the close analogy which subsists between the indigo group of compounds and those of creosote. This has been insisted on by Dr. Odling in an earlier volume of these reports, where the details of some interesting cases of melanuria have been recorded by Dr. Hughes.[2]

For the purpose of detecting indigo the following process was employed. The urine was made strongly alkaline by the addition of a solution of potash, and grape sugar was then added. A well-stoppered bottle was entirely filled with this mixture, shaken from time to time, and placed aside for sixteen hours. A deep brown, perfectly clear fluid was thus obtained, at the bottom of which a small cloud of phosphate of calcium rested. The clear fluid was decanted and freely exposed to the air, but no indigo-blue was deposited, as would have been the case if the urine had contained that pigment.

Some of the urine was next shaken successively with ether, and with a mixture of alcohol and ether; but these did not separate the colouring matter. The ether was then poured off, chloroform added, and the mixture again shaken. A milky emulsion was thus obtained, from which the chloroform could not be made to separate, but it was evident that this liquid had not dissolved the pigment. On adding a solution of potash to the urine this at once became clear and of a rich brown colour, the pigment being dissolved. Hydrochloric acid in the cold afforded a black deposit, consisting partly of pigment and partly of uric acid. This deposit, after being well washed with water, with alcohol, and with ether, still retained its colour, and was completely soluble in potash, yielding a rich brown solution. On boiling the urine with hydrochloric acid for some time a deep brown solution was obtained, and dark brown flocks were precipitated. These, after having been washed with hot water, alcohol, and ether successively, dissolved in potash to a rich brown solution. The urine did not reduce copper when boiled with an alkaline cupric solution; but, after being boiled with hydrochloric acid

[1] 'Guy's Hosp. Repts.,' Ser. III, vols. ii and iii.

for some time, the urine acquired the property of reducing such solutions. There was in this an intimation of the presence of a glucoside or sugar-producing body.

A portion of the urine was finally precipitated by neutral acetate of lead, filtered, and the excess of lead removed from the filtrate by means of a current of sulphuretted hydrogen. On filtering anew the filtrate was found to have entirely lost its black colour, and to have the appearance of ordinary urine which had been similarly treated.

It would be rash to speculate on the probable nature of the pigment here described. I am content to place this account of it on record, believing the substance to be one in many respects different from any of which a report has been previously given. I would merely draw attention to its distinctive properties. It is undoubtedly not blood pigment somewhat altered, as is the case with many dark urinary constituents, for the properties of the one I have reported are widely different. Moreover, microscopical examination merely revealed the presence of ordinary mucus corpuscles, a *very* few scattered corpuscles (the woman was menstruating), and the amorphous pigment. Nor was this indigo-blue, for it had distinctive peculiarities of its own, and no amount of exposure to air and treatment with reagents caused it to assume a blue colour.

CASE

OF

EXCISION OF THE SPLEEN

FOR

AN ENLARGEMENT OF THE ORGAN, ATTENDED WITH LEUCOCYTHÆMIA;

WITH REMARKS.

By THOMAS BRYANT.

Regarding it as the duty of a surgeon to place on record the details of every case—successful or unsuccessful—of any new or non-established operation, it devolves upon me to relate a second fatal case of extirpation of the spleen, which has just taken place in my practice at Guy's Hospital; and to this I have appended a few remarks which have been suggested to me by the experience which my two cases have afforded.

(Reported by Mr. George Vawdrey.)

H. F—, æt. 40, admitted under the care of Dr. Oldham and Mr. Bryant, September 27th, 1867, having been sent up to Mr. Bryant by Dr. Newnham, of Wolverhampton.

She has enjoyed perfect health all her life, and, until the present illness, was never laid up for a day since she can recollect. Her occupation has been that of housemaid for the last twenty-two years.

For the last five years she has lived at Wolverhampton, and the five and a half years previously she lived in Berkeley Square, London. She says she has never lived in any ague district, nor had any symptoms of that disease.

About two years and three months ago she noticed a sensation of fulness in the stomach and bowels, which she attributed to spasms. At this time no swelling was felt in the side. This feeling of fulness continued until last October, when, having caught cold, she felt severe pain all over the left side. She had no fever nor shivering. She called in a surgeon, who detected a *hardness*, which the patient herself could then feel. Fomentations, plaisters, &c., were applied, and she became perfectly free from pain, and went to work again. The hardness, however, continued, and she began to get weaker. Any cold brought on severe pain in the left side. The pain was felt especially in lying down. For the last six months she has suffered from occasional epistaxis.

She has been unable to lie on the right side for six months, because she cannot breathe in that position. The bowels have been relaxed all the time. Nine months ago menstruation ceased suddenly, and since then increased pain has marked what would have been the menstrual periods. She has gradually got weaker; and on the 25th September, 1867, she was compelled to give up her situation. On the 27th September she was admitted into Guy's Hospital.

On *admission* she looks very white and thin, the veins appearing very plainly all over the body. She says that she always feels very hot, and at night perspires profusely. She is slightly wasted. The skin is white and transparent, and feels hot and moist. Temperature in axilla 98° Fahr. at eleven a.m.

Heart.—The impulse can be felt between the fourth and fifth ribs, and also between the fifth and sixth ribs. Pulse 84. The heart sounds are loud, tumultuous, and irregular. A systolic bruit is heard especially loud at the apex, probably mitral.

Lungs.—Resonant, healthy; breathing rather loud.

The tongue is healthy but rather tremulous. Deglutition normal. No sickness, but an occasional feeling of nausea; no pain in the shoulders nor jaundice; occasional spasms; abdominal distension three or four hours after taking food; appetite very fair; bowels relaxed, three or four loose motions

of ordinary colour daily; no prolapsus ani; no menstruation, but at what should have been the periods she has severe pain in the left side, groin, and lower part of the abdomen.

Urine scanty; twenty-two ounces passed in the twenty-four hours; sp. gr. 1014, slightly albuminous. She complains that she has to get up two or three times in the night to pass it. No pain in micturition. Legs œdematous, the œdema passing off when she lies in the horizontal position. Eyesight good. No deafness. Occasional epistaxis.

Abdomen.—At the umbilicus the abdomen measures thirty-six and a half inches round, increasing one-eighth of an inch with inspiration. The superficial veins are very plain and full. The ensiform cartilage is pushed upwards and forwards on itself, so that it points perpendicularly to the skin.

A large tumour, with well-defined outline, is to be felt, extending all over the left side and centre of the abdomen. There is no resonance on percussion over any part of it. It extends as high as the sterno-xiphoid articulation, and the dulness on percussion apparently due to it reaches over the left ribs at the side as high as the nipple. The outline of the tumour can be traced from the ensiform cartilage along the middle line of the abdomen to about two inches above the umbilicus, where it passes gradually over to the right side, and at the level of the umbilicus is two inches to the right of its centre. It still inclines to the right till its border passes underneath the *centre* of Poupart's ligament. The rounded angle which it forms here can plainly be felt. No distinct notch is discoverable in its anterior border, which is sinuous. The anterior surface of the tumour is in contact with the anterior wall of the abdomen, no viscus intervening throughout its entire course. Its lower border cannot be felt above the symphysis pubis. Posteriorly its margin can be felt (taking the patient in the upright position) extending obliquely downwards and outwards, from the top of the eleventh rib to the crest of the ilium, about two and a half inches from the left sacro-iliac synchondrosis; below this it seems to dip towards the pelvis. The position of the anterior border varies, according to distension or otherwise of the bowels, as much as half an inch. The measurement from the centre of the umbilicus to the spinous processes of the vertebræ is on the left side eighteen and a half inches; on the right side eighteen inches.

The blood, obtained by puncturing the finger, was examined microscopically, and the white corpuscles were *rather more numerous* than the red;—more numerous than in a parallel case under Mr. Bryant in 1866. The red corpuscles adhered very closely to one another, occupying much less space than the white, and at first sight appearing less numerous than they really were. Sufficient blood was not obtained to observe the characteristics of the leukhæmic clot.

The operation.—Splenotomy was performed by Mr. Bryant on November 9th. The patient was placed in a private room, and the same rules were observed in respect to the visitors as Mr. Bryant always carries out in his operations of ovariotomy. Mr. Cock and Dr. Hilton Fagge were present, and Mr. Durham kindly gave his assistance. The patient was placed under the influence of chloroform, and an incision made in the left loin, commencing below the ribs, at a point corresponding to a line extending upwards from the anterior superior spine of the ilium, and curving downwards and forwards in front of the crest. This line of incision was selected as it was supposed to correspond to the horizontal line of the spine, and would thus, on the removal of the spleen, enable the surgeon to have the pedicle of the gland more immediately under his observation and control, and tend to prevent the risk of its being stretched or perhaps lacerated; it would at the same time allow of the removal of the very large organ in the readiest manner. The peritoneum was opened, and after some little manipulation the lower part of the spleen was turned out of its position, no single adhesion interfering with this step of the operation. The upper part of the organ was then carefully separated from its connections with the lower surface of the diaphragm, these parts being in close contact by means of innumerable soft sponge-like adhesions. These, however, readily gave way before the hand, tearing like a rotten sponge. The pedicle was then isolated, and was about four inches in diameter. It was, by the means of the line of incision adopted, brought admirably under view: it was ligatured in four portions with a strong whipcord, and the spleen cut off. No signs of bleeding came from the pedicle. During this step of the operation some blood was seen to trickle from the wound, and on raising the ribs the left hypochondriac region was seen to be filled with blood.

This was at once removed, and some large vessels looked for, but none were to be seen, for the bleeding clearly came from the sponge-like adhesion which had been torn through, connecting the spleen with the lower surface of the diaphragm. All attempts to arrest the hæmorrhage were quite fruitless; indeed, it was feared the patient might die upon the operating table. The wound was consequently closed and the abdomen bandaged, the patient being placed in bed. She survived her removal, however, only fifteen minutes.

The following account of the post-mortem examination is from Dr. Moxon's report. The autopsy was made twenty-four hours after death:—

The lungs were anæmic, but very perfect. The cervical glands were slightly enlarged. The glands in the anterior mediastinal space were of the size of horse beans; two bunches of glands double that size existed in the posterior mediastinum, three inches below the bronchi. The mesenteric, lumbar, and iliac glands were likewise twice their natural size.

The heart contained very little blood, which was liquid in both cavities.

The region of the spleen had more than a pint of blood in it. This was liquid, and its upper part was pale and cream-like, from the red corpuscles having sunk. The blood had not forced its way beyond the left hypochondriac and lumbar regions.

There was a full meal of meat in the stomach.

The liver weighed one hundred and thirty-eight ounces. It was flat and spread out, and very flaccid. On section it was of a uniform light, rather opaque, liver colour. The lobules were coarsely large. There was no morbid paleness, as of blood, round the portal canals. The peritoneal coat was acutely inflamed, and coated thinly with plastic lymph on the right lobe.

Microscopical examination showed enormous quantities of lymphoid corpuscles between the hepatic cell columns, which latter were small. The individual cells were also small. No fat was present, and only a moderate quantity of pigment. Sections plunged at once in syrup without washing showed only a small number of red corpuscles, so that the lymphoid corpuscles could not represent merely a large lodgment of leuk-

hæmic blood. The position of these was such as to lead Dr. Moxon to believe them to be in the place of the hepatic cells. The position that should have been occupied by another hepatic cell column was occupied by a similarly shaped column of these lymphoid bodies.

The kidneys weighed fourteen ounces. They were of a pale cream-yellow pink colour. One of them was marked on the surface with circular yellow spots (from the size of pins'-heads to that of peas), giving it very much the appearance of a "surgical kidney." On microscopical examination it was found that most of the epithelial cells in the kidneys were small and loose, and many lymphoid corpuscles existed in the interstitial tissue. The Malpighian corpuscles were large and full of lymphoid corpuscles.

The spleen, after removal, was found to weigh ten and a quarter pounds. Its surface was pretty even, but marked with several pale yellowish patches, which, on section, were found to resemble embolic patches, entering deeply into the substance of the organ. They were composed of the splenic tissue, altered only in colour, and in being slightly increased in bulk and consistency. Some were softer than others, but none were so soft as the rest of the spleen. Each of these masses was surrounded by a narrow, intensely purple zone.

Remarks.—The first point which will attract the attention of the thoughtful reader of the case which has been just recorded is the fact that, after death, nearly all the glands in the abdomen, and others in the body, were found to be more or less diseased.

He will likewise find the nature of the disease with which all these glands were affected, to be essentially of the same character; and to consist apparently of a free infiltration of the several tissues with lymphoid corpuscles.

If he refers to the case recorded in the last volume of these reports, he will find the same fact equally recognizable, although not, perhaps, to the same degree.

Under these circumstances he would necessarily be tempted to the conclusion, that in these cases of leucocythæmia the disease of the spleen is only part of a more general affection; and that as a consequence the operation of splenotomy as a

means of cure is physiologically unsound, and without good proof to the contrary surgically unscientific.

It is not my intention to argue against the truth of these conclusions, for the facts I have recorded, as far as they go, certainly tend to bear them out. On the contrary, I am willing to confess that, to my own mind, they have now considerable weight, and tend to prove that the operation of splenotomy for leucocythæmia is based on a wrong foundation, and as a consequence should not be performed.

We will now proceed to the subject of the operation itself, and to read the lesson which the experience of the two cases has afforded.

The operation.—With respect to the operation itself no surgical difficulty is to be recorded; by the line of incision adopted in the case just reported, the largest splenic tumour may be removed with comparative facility, and, what is of equal importance, its pedicle, however extensive, brought readily under observation, and treated with confidence and precision. In the present case the tumour was very large, and the pedicle very broad, yet no difficulty was experienced in their management.

We now come to the question of hæmorrhage and its treatment, for both cases clearly died from such a cause.

In the first case recorded the patient died from the bleeding of an isolated vein, which was lacerated during the operation. In the second case death was due to the rapid oozing of blood from innumerable capillary points. In the former case the bleeding took place after the patient had been placed in bed, and a careful examination of all the parts had been made, when everything appeared safe. In the latter the bleeding immediately followed the operation, and was so rapid and extensive as to defy treatment. In this last fact we have a surgical difficulty of no mean importance, for all who had an opportunity of witnessing the hæmorrhage at the operation must have been convinced that with such a hæmorrhage surgery is quite incompetent to deal. The blood flowed from the whole surface of the left half of the diaphragm as from a squeezed and saturated sponge. There was little time for treatment, and all treatment seemed useless.

Under such circumstances a surgical objection of great

weight must be advanced against the operation of splenotomy for leucocythæmia, for this is a difficulty which cannot be foreseen, and if foreseen cannot be conquered.

How far this hæmorrhage after the operation is to be explained by the hæmorrhagic tendency of the disease is of little importance, for it clearly exists, and as a difficulty in splenotomy appears insuperable.

We have thus learnt two things from the cases related.

Firstly, that the enlargement of the spleen in leucocythæmia appears to be only part of a general disease affecting the glandular system as a whole; and secondly, that in splenotomy for such a disease there is a disposition to hæmorrhage with which surgery is incompetent to deal. It can neither be foreseen by any amount of care, nor coped with by any amount of skill.

Under such circumstances there is no shirking the conclusion that the operation is physiologically unsound and surgically unsafe, and for leucocythæmia should not be performed.

These observations are well supported by the case recently recorded in the 'Med. Times and Gaz.' (November 2nd), to have died under the hands of Dr. Kœberle of Strasburg, hæmorrhage from the small vessels of the ruptured adhesions being described as the cause.

The successful case by Dr. Pean of ablation of a splenic cyst and complete extirpation of the hypertrophied spleen, recorded in 'L'Union Médicale' of November 28th, is of no importance so far as our present argument stands, for in his case there is no record of the fact that leucocythæmia existed. It is of value, however, in supporting the argument that a spleen may be removed from the human subject as it may from the animal without life being necessarily destroyed.

CASES

OF

MALPOSITION OF THE TESTICLE,

AND OF

MALFORMATION OF THE MALE AND FEMALE URINO-GENITAL ORGANS.

By THOMAS BRYANT.

There is in the cases about to be related nothing very novel to men conversant with the practice of a metropolitan hospital, for at these institutions strange and varied examples of deformities of all parts of the body pass occasionally under observation; still the cases are of sufficient rarity to the great body of the profession to be of interest, and consequently have been deemed worthy of publication in a hospital report.

They have been taken from the brief notes which were written down when the cases originally came under observation, and the drawings from the rough sketches likewise made at the time in my note-book, in which it will be observed that brevity of description has been carefully studied and mere outlines have been given.

Case 1.—*In which the right testicle was placed in the perinæum* (*vide* fig. 1, Plate I).

Henry K—, æt. 6 weeks, came under my care at Guy's Hospital on March 22, 1866, with the following deformity:

The right testicle was placed on the right side of the perinæum, in its own independent scrotal pouch; it was of

normal size, and had a cord which passed downwards through the external abdominal ring as in the natural condition. The left testicle was in its usual place, in its own scrotal bag. This bag had no connection with the one containing the right testicle.

The penis was well formed, and the child was in all other respects well made.

The father of this child had had his right testicle excised for disease one year before his marriage. He had one other child, a female, who was well formed in all respects.

Remarks.—This case is one of unusual interest, from the strange position assumed by the right testicle. Similar cases have been recorded by other authors, but their rarity forms a sufficient excuse for the publication of the present one, with the accompanying drawing. It is no part of the task I have given to myself to explain the means by which such a malposition of an important organ took place; I simply place it on record as material for future observation. The fact that the child's father had lost his right testicle one year before his marriage is one of special interest, although, perhaps, no connection can fairly be made out between the natural displacement of the child's organ and the surgical displacement of the father's.

It is worthy also of note (although the fact is not a new one), that a man with one testicle should have preserved his power and proved his manhood by doing his part towards the production of two children.

Cases of imperfect transition of the testicle.

These cases are by no means uncommon. Every practitioner at times must have such passing under his observation. Amongst those I have recorded in my note book the following may be selected as possessing points of interest beyond the mere retention of the testicle or testicles in the abdominal cavity, or inguinal canal:

Cases of nondescent of the testicles, &c.

Case 2.—George P—, æt. 7½, came to me at Guy's Hospital,

in May, 1865, with the left testicle in the scrotum. The right testicle was in the inguinal canal, as at birth. One year subsequently the right was still in the same position.

Case 3.—Edward B—, æt. 10 months, came under my care in March, 1866, with a congenital hernia on the right side; the right testicle had not descended, but the right scrotal pouch was perfect. The *left* testicle was in the inguinal canal, and there was no left scrotal sac.

Case 4.—Edward R—, æt. 8, applied to me at Guy's, in March 26, 1858. He had been born without testicles externally. The left had descended into the scrotum one year, where it had remained. The right had descended on March 24th, but reascended the next day, and six months later it had not reappeared.

Case 5.—John Young, æt. 6, came under my care in February, 1861, with the right testicle in the scrotum, the left at the internal ring. One year subsequently these testes were *in statû quo*.

Case 6.—William H—, 7 weeks old, was brought to me with the left testicle in the scrotum, and the right in the canal, with a large reducible bubonocele.

Two years subsequently no change in the relative condition of the parts had taken place.

Amongst the accidents to which a testicle is exposed in its passage from the abdomen into the scrotum that of inflammation is the most common. It is well illustrated by the following case:

Case 7.—*Inflammation of the testicle when passing down the inguinal canal.*

Robert H—, æt. 12, came under my care at Guy's Hospital, on June 20, 1859, under the following circumstances:

The *right* testicle was not to be felt, having, evidently, not descended from the abdomen.

The *left* had put in its first appearance at the external ring three days before his application to me, the boy having experienced pain in the groin, extending upwards towards the loin, for two weeks previously. On his walking into the room I at once observed that his body was bent unusually forwards, and that his movements were much restrained.

On examination the testicle was readily felt in the left groin, having passed down the canal, and partially through the external ring. The gland was of a large size, remarkably tender, and was about the size of an egg. The horizontal posture was ordered to be maintained, with the thigh flexed, and cold lotion was applied. In three days the symptoms had somewhat abated, and at the end of the week the swelling was less.

On July 11, the twenty-first day after his coming under observation, the testicle had passed the external ring, although resting close to it in the scrotum. In another week all pain had subsided, the testis was free, and the patient disappeared from observation, being quite well.

Hypospadias.

It is not worth while to record all the numerous cases of hypospadias which have passed under my notice, for they are very similar in their nature, and have few special points of interest. It may, however, be interesting to observe that the urethral orifice in the majority of cases is placed below the glans at a spot corresponding to the preputial frænum; that in a certain number there is a depression on the glans penis corresponding to the natural outlet; and that several small depressions often exist between the urethral orifice and the cup-like depression at the extremity of the glans. One or more foramina through which urine escapes also sometimes present themselves below the true opening of the urethra; but under these circumstances the urethral orifice is generally small, too small for its office. Under such conditions it often requires to be laid open.

It would seem also that this deformity is one which is frequently inherited, but whether more frequently than others I have no means of proving.

Case 8.—I have notes of a case of twin children, who were born with this condition, and whose father had precisely the same form of penis.

Case 9.—Another patient, æt. 25, came also under my care, with a urethral orifice below the glans penis, who was the father of three male children, and in all of them a like deformity existed.

Case 10.—In a third case a man had four children, three of whom were males, and all three, like their father, had hypospadias; the opening of the urethra corresponding to the frænum.

Case 11.—In the case of a man, æt. 25, with a urethral orifice one inch behind the glans, it may be interesting to record that he was married, and that his wife died in childbirth, proving that marriage and conception are both possible under such improbable conditions.

The two next cases I have to relate are also cases of hypospadias, but in both the urethral orifice was placed much further back than in the others to which allusion has been made.

The orifice of the urethra in both was situated at the base of the penis, at the upper part of a fissure caused by a bifid scrotum.

In one case the testicles could not be discovered in the scrotal pouches, and thus the question of sex was necessarily raised; in the other this question was not a disputed one, as excess of sexual feeling produced results which caused the man to seek my advice. The second case, having been under my care a few months before the first, enabled me to decide the point respecting the latter without much difficulty.

Case 12.—*Case of Hypospadias; bifid scrotum; orifice of urethra in scrotal fissure at base of penis. Query as to sex.*

A child, named Frost, three weeks old, was sent to me by Mr. Hopkins, of Shoreditch, with the following deformity, in July, 1867. It was the first child of well-formed parents.

There was a short penis, with glans and prepuce curved well downward, and held in position by a fibrous band.

In this penis there was no sign of a urethra.

At its base an opening existed which communicated with the bladder.

On either side were two bags corresponding to the labia or to the scrotum, in which no testes could be discovered. Between them there was a deep fissure, at the upper part of which was the urethral orifice.

There was no vagina.

The anus was perfect; on introducing the finger into the bowel a uterus could not be made out.

The pelvis was small, as in a male.

The question was put to me as to sex. The weight of evidence tended towards the opinion that it was a male. In my note-book I entered it as Jack Frost.

In the year 1864 a precisely similar case came under my care.

Many cases similar to the above have been recorded, and the persons have during life passed as females.

CASE 13.—*Hypospadias; bifid scrotum; testitis as a result of ungratified sexual excitement.* (*Vide* fig. 3, Pl. I.)

Robert C—, æt. 20, was sent up to me by Mr. Harding, of Woolwich, on January 16th, 1867. He was one of five brothers, four of whom were healthy and free from deformity. The penis in Robert C— was well formed but stunted, with a good glans and full prepuce. A depression existed at its extremity corresponding to the orifice of the urethra, and at its lower part were several foramina, but none communicated with the urethra. The scrotum was divided into two pouches, and each pouch contained a testicle. At the upper part of the fissure, dividing these pouches, the true urethral orifice existed. The lower part of the penis from the urethral orifice was held down by a firm fibrous band, and when an erection of the organ took place the penis was bent downwards over the scrotum. The right testicle was of the normal size, but the left was enlarged from inflammation of three days' standing. This inflammation had come on after intense sexual excitement, which he had been unable to gratify from the unnatural position the penis assumed under such circumstances. After a few days' treatment the inflammation subsided.

The man came to me to have castration performed, as he had strong sexual passions and was perfectly unequal to sexual connection. I need hardly say that the operation was not performed.

Cases of Epispadias.

I now propose to quote a few cases of epispadias, partial and complete, as found in the male and female sex. It is said to be more common in the former than in the latter, and my own experience would confirm this fact.

In the first case the epispadias appeared to involve only the urethra. In all the others the urethra and anterior wall of the bladder were similarly involved.

In several of the cases to be recorded the possibility of operative interference was passed in review, and in all it was deemed wiser to wait, for nature does much in causing the retraction of the parts into the pelvic depths, and when this retraction has been perfected the prospects of operative success seem to be much improved.

CASE 14.—*Epispadias in male, and bifid scrotum.* (*Vide* fig. 2, Pl. I.)

Henry C—, æt. five weeks, came under my care at Guy's Hospital on October 30th, 1865, for the following deformity:—

The penis was well formed as to size and appearance of the glans, but the urethra was completely deficient on its upper part. The exposed mucous surface passed backwards towards the pubes into a hollow, or rather fissure, which was covered in by a thin fold of integument passing transversely across the part. Through this fissure the urine passed freely.

The scrotum was large, and contained the two testes, but was fissured in the centre, giving the appearance as if formed of two sacs.

CASE 15.—*Epispadias in a male, with extroversion of the bladder.* (*Vide* fig. 6, Pl. II.)

Tom P—, æt. 23, a countryman, came up from Cambridge and presented himself before me at Guy's Hospital on June 3,

1867, with complete epispadias and extroversion of the bladder. The penis was small and stunted. The mucous membrane of the bladder was very red, and the orifices of the ureters were out of view in a deep fissure behind the pubes. The scrotum was somewhat bifid, and contained the two testicles.

In this case it appears highly probable that the retraction of the penis and ureters into the abdominal fissure had been slowly taking place.

Case 16.—*Epispadias, and extroversion of bladder in a male.*

Daniel C—, æt. one month, came under my care at Guy's Hospital on July 30, 1865, with complete epispadias and extroversion of the bladder. The mucous surface of the posterior wall of the bladder was red and vascular, but granulating and cicatrizing, more particularly at its upper part; the orifices of the ureters projected laterally. The penis was rudimentary, with an ill-formed glans and prepuce. The urethra was deficient along the whole of its upper surface. There was a well-formed scrotum, and both testicles had descended. On the left side a bubonocele existed.

By November 21st cicatrization of the mucous surface had much advanced, with retraction of the whole into the pelvis. The orifices of the ureters could only be seen by making traction on the parts. The case appeared to be a good one for operation when the retraction of the parts should have ceased. The child, however, unfortunately died in a fit on December 3rd.

Case 17.—*Epispadias, and extroversion of the bladder in a male.*

George P—, æt. 2½ years, came under my care on May 22nd, 1865. He was one of seven children, and the only one who had any deformity. From the umbilicus down to the pubes the mucous membrane of the extroverted bladder was freely exposed; the orifices of the ureters were visible towards the lower part.

The penis was short, and the urethra at its upper part was completely laid open. The pubic bones seemed tolerably close together. The testes were both down, and in a fairly-formed scrotum.

When this child was again seen on October 26th the mucous membrane of the bladder was skinning over at its upper border, and the parts were being well drawn downwards into the pelvis. The orifices of the ureters had disappeared in the pelvic depression, and the penis had become much shorter.

Case 18.—*Epispadias, with extroversion of the bladder in a male, and talipes equino-varus.*

Charles T—, 1 week old, was brought to me at Guy's Hospital on September 17th, 1866, with complete epispadias and extroversion of the bladder. The penis was small, with a large prepuce. The orifices of the ureters projected as small nipple-like processes from the lower part of the exposed mucous membrane. The scrotum was natural, and contained both testes. The left foot was the subject of complete talipes equino-varus.

On October 15th the penis had become shorter from the retraction of the parts into the pelvis. The ureters had passed out of observation into the depression above the pubes.

The case seemed to promise well for subsequent operation.

The talipes was treated by means of strapping with good success.

Case 19.—*Epispadias in a female child, with extroversion of the bladder, &c.*

Alice Y—, æt. 8 years, was brought to me at Guy's Hospital on November 5th, 1866, with the following deformity:

The mucous membrane of the posterior wall of the bladder was exposed, with the two orifices of the ureters at the lower part.

The upper part of the urethra was completely deficient, the exposed mucous membrane of the urethral passage being visible for about one inch in its anterior part; the vesical end was lost in the pelvic depression. The labia were of normal size. There was no vagina, and on passing the finger into the rectum a uterus could not be made out.

The anus was natural.

CASE 20.—*Epispadias in a female, with extroversion of the bladder.* (*Vide* fig. 5, Plate II.)

Rosetta J—, æt. 11 months, was brought to me at Guy's Hospital from Gravesend on July 1st, 1867.

From the umbilicus to the pubes the space was occupied with the exposed mucous surface of the posterior wall of the bladder; at its lower part were the orifices of the two ureters. The urethra appeared only as a channel about half an inch long, its vesical end being lost to view in the pelvic fissure.

Two labia existed, but the left was slightly larger than the right.

There was no vagina, nor any sign of one.

The anus was natural.

It is worthy of note that in both of these cases of malformation the vagina appeared to be deficient.

CASE 21.—*Extroversion of the bladder, &c. &c.* (*Vide* fig. 4, Plate II.)

A child named L—, one week old, was brought to me at Guy's Hospital in September, 1863, on the recommendation of Mr. Babbage, of the Old Kent Road, with the following deformity:

The bladder was extroverted, and its posterior mucous surface was exposed, with the two orifices of the ureters at its lower part; the skin between the umbilicus and the mucous surface was ulcerated. At its lower surface there was an opening, or rather fissure, through which urine escaped, and the mucous surface of a female urethra, the subject of epispadias, could be detected.

On either side were attempts at the development of labia, but the folds of skin were small. There was nothing like a vagina. To the right side of the mucous surface, and at its lower part, towards the natural position of the anus, an anal opening existed with a sphincter; it was far out of the median line. There was no anus in the natural position. The child was otherwise well developed.

CASE 22.—*Absence of Vagina.*

Julia D—, aged 7 years, came under my care at Guy's Hospital on January 26, 1863, with the following deformity:

There was a total absence of all sign of a vagina; no cicatrix or depression corresponding to the orifice.

The urethral orifice existed in its natural position, and two well-formed labia were present, with a perinæum and anus, but the fissure between the labia was completely closed, and on a careful pelvic examination through the rectum no uterus could be discovered. The pelvis was broad. The child in other respects was quite natural, and had the appearance of a female.

CASE 23.—*Enlargement of clitoris, with attempt to form urethra.*

Louisa S—, æt. 6, was brought to me at Guy's Hospital on June 12, 1867, with an enlargement of the clitoris much resembling a small penis. The organ was well formed, like a penis, with glans and prepuce, the latter being very large. At the extremity of the glans there existed a fossa corresponding to the natural male urethral outlet; but at the base of this clitoris or abortive penis the true urethral orifice existed.

The labia, vagina, and other parts were quite natural.

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. Illustrating Case 1, and showing the right testicle in the perinæum, with the left drawn to one side by a hook.

Fig. 2. Illustrating Case 14.

a. Transverse fold of integument, forming the upper margin of the fissure leading into the bladder.
b. Urethra, the subject of complete epispadias.
c. Body of the penis.
d. Prepuce.
e. Bifid scrotum containing testes.

Fig. 3. Illustrating Case 13.

a. Depression corresponding to the position of the natural orifice of the urethra.
b. Orifice of the urethra, at the root of the penis, in the upper part of the scrotal fissure.
c. Bifid scrotum containing testes.

PLATE II.

Fig. 4. Illustrating Case 21.

a. Umbilicus.
b. Ulcerated surface between the umbilicus and the upper border of the mucous surface of the bladder.
c. Mucous membrane of the extroverted bladder.
d. Orifices of ureters.
e. Urethra, the subject of complete epispadias.
f. Labia.
g. Anus out of position.

Fig. 5. Illustrating Case 20.

a. Mucous membrane of extroverted bladder.
b. Orifices of ureters.
c. Urethra, the subject of complete epispadias.
d. Labia.

Fig. 6. Illustrating Case 15.

a. Mucous membrane of extroverted bladder.
b. Penis, the subject of epispadias, retracted into pelvis.
c. Bifid scrotum containing testes.

Plate 1.

Fig. 1.

Fig. 2.

Fig. 3.

W.Hurst. ad.nat. delin. M&N Hanhart imp.

Plate.2.

Fig. 4.

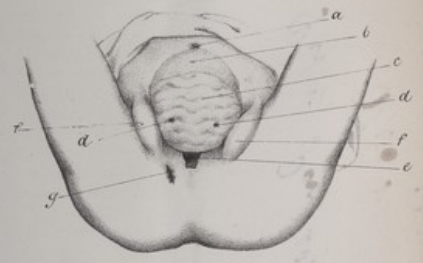


Fig. 5.

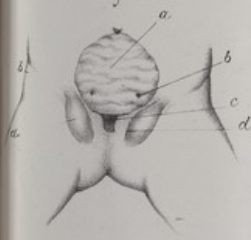


Fig 6.

Ehrt. adnat. delin.

M & N. Hanhart. imp.

From the *Journal of Anatomy and Physiology*, Vol. II.

ELECTROTONUS. *A Physiological Demonstration given in the Physiological Laboratory of the University of Edinburgh,*

by WILLIAM RUTHERFORD, M.D., *Demonstrator of Practical Physiology.*

GENTLEMEN,

You have already witnessed the fact, that when a continuous galvanic current of equable strength is passed along a motor nerve, contraction of the muscles supplied by the nerve takes place only when the current begins or when it ends, and that *during* the passage of the current the muscles remain at rest. From this fact you might suppose that the nerve is unaffected *during* the transmission of the current, but it is not so; the current all the while it traverses the nerve induces in it a peculiar state, termed the electrotonic state or simply electrotonus.

This state of the nerve is characterised by a variation, 1st, in the degree of its excitability, 2nd, in the rate at which the nervous influence is transmitted by it, and 3rd, in its electromotive power. In fact, in the state of electrotonus, the whole physiology of the nerve is altered, and the extent of the alteration is directly proportionate to the strength of the continuous current employed.

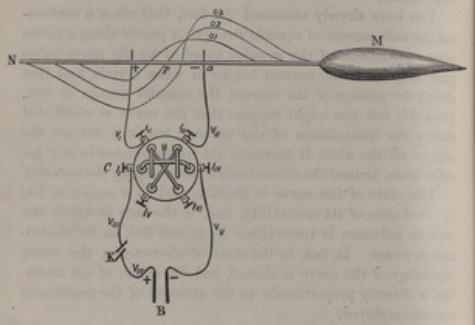
These changes I hope to demonstrate to you in motor nerves: it is probable that precisely the same variations characterise the electrotonic state in sensory nerves; this indeed has been shown to be the case as regards the excitability and the electromotive force, but the variation in the rate of sensory nervous conduction has not yet been demonstrated.

I propose to show you in the first instance the *Electrotonic variation of the excitability.*

I have here the lower part of a frog's limb amputated at the middle of the thigh. The sciatic nerve has been isolated in its whole extent, its attachment to the gastrocnemius only being preserved. I fix the femur in a pair of strong brass forceps supported by a stand. I place the limb in a horizontal position with the gastrocnemius uppermost, so that when relaxation follows moderate contraction of the latter, the limb may by its own weight recover its former position.

I place the nerve (N) on a pair of zinc wires ($V_{'}$ $V_{''}$ Fig. 1), which are insulated by cork, and supported at a convenient height by a stand. I connect the wires with a Pohl's Commutator[1] (C), and it in turn with a Du Bois Reymond's Key[2] (K),

Fig. 1.



Gastrocnemius, M. Sciatic Nerve, N. Commutator, C. Key, K. Battery, B. Wires from commutator to nerve $V_{'}$ $V_{''}$, from battery to commutator $V_{'''}$ $V_{''''}$.

[1] Pohl's commutator consists of a circular piece of mahogany an inch in depth and four inches in diameter. A minute description of the instrument would be tedious, suffice to say, that the wires from the battery, or induction machine, are always connected with $I_{'}$ and $I_{''}$. When the instrument is used to reverse the direction of a current, the pair of wires in which the current is to be reversed are connected to $I_{'}$ and $I_{'''}$; and the direction of the current is changed by simply turning the arched handle H on the upper surface of the instrument so that its branches may at one time dip into the mercurial cups near $I_{''}$ and $I_{'''}$, at another, into those at I_{r} and $I_{r,}$. The instrument may also be used to send a current at one time through one pair of wires, at another time through another pair. For this purpose the oblique wires are removed from the surface of the instrument, and one pair of wires connected with $I_{''}$ and $I_{'''}$, and another with I_{r} and $I_{r,}$. The current will pass through the one pair where the handle is connected with the cups at $I_{'}$ and $I_{'''}$, and through the other when it is connected with the cups at I_{r} and $I_{r,}$.

[2] See Appendix A.

(with which the electrical circuit may be closed and broken), and a Grove's battery (B), in which about twelve square inches of zinc are exposed to the action of the acid (one part of ordinary sulphuric acid to eight parts of water). That you may better comprehend these arrangements, I will represent them by a diagram.

When the key is closed and the handle (H) of the Commutator is in the position represented in the diagram, the current must pass from $I_{'}$ to $I_{''}$ along $V_{'}$ down the nerve, that is, towards the muscle. In that case the negative pole will be the wire nearest the muscle. But if the handle be turned so that its curved branches will no longer be in connection with the cups at $I_{''}$ and $I_{'''}$ but with those at I_{r} and $I_{r,}$, the current will pass from $I_{'}$ to I_{r} along the oblique wire from I_{r} to $I_{'''}$ and thence to the nerve, so that in this case the wire nearest the muscle will be the positive pole.

Now the arrangements for our experiment are completed, we have only to close the key, and a continuous galvanic current will flow through the nerve. But how shall we find out whether or not any variation of the excitability is produced during its flow? Bear in mind this fundamental fact, that the result of irritating a tissue will depend, 1st, on the nature and strength of the irritant, and 2nd, upon the irritability or excitability of the tissue. For example, if I give my finger a slight prick, I produce slight pain; if I give it a severe prick, the pain is intense; but if I freeze my finger, and then prick it, no pain results, not because the irritant has been affected by the cold, but because the irritability has been suspended. A convenient irritant for the nerve in this experiment is a saturated solution of common salt, as recommended by Eckhard. I apply a drop of it to the nerve (at a) between the muscle and the nearest wire, about a quarter of an inch distant from the wire, so that the influence of a current passing along the wire may extend to the spot where the drop of salt is placed. We wait until slight tetanus of the muscles results from the action of the salt upon the nerve, and then remove the superfluous drop with blotting-paper in order that the tetanus may not become too marked. Now close the key. You observe that the tetanus

is instantly increased. Pay no attention to the *sudden* increase, for you know that a nerve is irritated at the moment of closing or opening a constant current, but observe that the increase of the tetanus continues during the passage of the current. Now by means of the Commutator reverse the direction of the current in the nerve. You see the tetanus is diminished, and continues to be less marked than it was before the current was sent through the nerve at all. Now open the key. (You thereby stop the current.) Notice, the tetanus becomes very nearly what it was before the current was sent through the nerve. If you examine the arrangements you will see that when the tetanus was in the first instance increased, the wire nearest the irritated spot must have been the negative pole, and that when the direction of the current was reversed, this wire must have constituted the positive pole. But it does not necessarily follow, that because the tetanus was more marked when the negative pole was nearest the irritated spot than it was when the positive pole was in that position that therefore the influence of the + pole is the reverse of that of the − pole, for it may have been that the nerve was becoming exhausted by continued passage of the current, and that in consequence of this the tetanus was diminished. To meet this objection, we repeat the experiment in an inverse order. We will bring the irritated spot first under the influence of the + and then under that of the − pole. You see the phenomena are the same, though their order is changed. When the irritated spot is brought under the influence of the + electrode, the tetanus of the muscle is diminished, whereas under the influence of the − electrode it is increased. We certainly cannot explain these two facts by supposing that the current alters the irritant; for the same results are obtained when a mechanical irritant is used, so that we are compelled to believe that they are due to a variation of the excitability of the nerve, that while the − electrode increases the excitability, and thereby augments the effect of the irritant, the + electrode lowers the excitability, and thereby diminishes its effect. You observed that the salt was placed on the nerve at a little distance from the wire along which the electricity passed, and moreover on a portion of

nerve which did not form a part of the electrical circuit; so that we have proved that the electrodes or poles influence the parts of the nerve which do not lie between them; in other words, the extrapolar as distinguished from the intrapolar portion.

It would require a great number of experiments to ascertain the distance to which a current of any strength extends along the extrapolar portion of the nerve, and it would take too much time to demonstrate the variation of excitability in the intrapolar portion of the nerve; I must therefore simply tell you what has been ascertained by Prof. Pflüger[1] of Bonn. The facts which I have shown you, however, were discovered by Prof. Eckhard[2] of Giessen.

Pflüger found that the distance to which the influence of the constant current extends along the extrapolar portion of the nerve, and the degree to which the excitability is raised or lowered, are in direct proportion to the strength of the current employed.

We may indicate the variations of excitability by curved lines, drawn *above* the nerve in the diagram when the excitability is increased, and drawn *below* the nerve when the excitability is diminished. I will draw three lines ($O_1 O_2 O_3$, Fig. 1) above the extrapolar portion of the nerve near the negative pole, and three below the nerve in the positive extrapolar portion. The three lines indicate three degrees of the excitability. O_1 produced by a weak current, O_2 by a strong current, and O_3 by a current of medium strength. The lines are farthest separated from the nerve at the respective poles, because there the polar influence is most marked, becoming less and less as the distance from the pole increases. While this is true of the extrapolar portion of the nerve a somewhat different story must be told of the intrapolar portion. With a current of medium strength this part of the nerve is divided equally between the two poles, the half on the side of the negative pole having its excitability raised while the other half has it lowered. The one pole seems to neutralize the influence of the other, so that

[1] Pflüger, *Untersuchungen über die Physiologie des Electrotonus*. Berlin, 1859.
[2] Eckhard, *Beiträge zur Anatomie und Physiologie*. Heft 1. 1855.

at a point equidistant from the two the excitability is unchanged, and this point is in consequence termed the neutral point, or point of indifference (*p*). When a weak current is used the neutral point approaches the + pole, while with a strong current it approaches the − pole. In other words, in a weak current the − pole rules over a wider territory than the + pole, whereas in a strong current the + pole prevails.

The shifting of this neutral point is really a most curious fact, which has received no explanation.

You see then that the influence of the + pole, or anode, is opposed to that of the − pole, or cathode; the condition produced by the anode is therefore termed Anelectrotonus, while that produced by the cathode is termed Cathelectrotonus, these form, as it were, the two halves of electrotonus.

We have shown by this experiment that the influence of the − pole is that of a *latent stimulant*, it increases the excitability; whereas the + pole is a *sedative*, it lowers the excitability. And I think this shows us that when we employ a continuous galvanic current with a view to remedy diseased conditions of the nervous system, we ought to subject hyperæsthetic portions as much as possible to the influence of the + pole and anæsthetic portions to that of the − pole. I will however discuss this more fully on a future day.

We shall now perform another experiment, in order to see what is the *Electrotonic variation of the rate of nervous conduction;* that is, of the rate at which the nervous influence is transmitted by the nerve trunk. Already this interesting subject has been investigated by Professor von Bezold of Jena. I will tell you, however, what his conclusions are when we have performed our experiment.

I take for granted that you remember the manner in which, by means of Helmholtz and Du Bois Reymond's myograph, we calculated the rate at which the nervous influence travels in the sciatic nerve of a frog[1]. We will repeat that experiment, with this novel feature however, that we will make arrangements similar to those employed by us in the experiment you

[1] See Appendix B. The reader is requested to read the description of the instrument and experiment in the Appendix ere he proceed with the above.

have just seen, for passing a constant current through a portion of the nerve. A diagram will enable you to understand the experiment. (Fig. 2), Sciatic nerve of frog (*n*), gastrocnemius (*m*), wires for continuous current I connected with the same arrangements as in the previous experiment (Fig. 1). Two pairs of wires (II and III) with which to irritate the nerve by an induction shock, at one time close to the muscle, at another close to the pole of the constant current which is nearest the muscle, our object being in this, as in the former experiment on this subject (see Appendix B), to ascertain the time taken by

Fig. 2.

the nervous influence to pass from the part of the nerve on the wires at II to that on the wires at III.

After the experiment which you have just witnessed you will readily understand that when a constant current is passed from 1′ to 1″—1″ being in that case the negative pole—that a portion, if not all, the nerve lying between 1″ and the muscle will be thrown into the Cathelectrotonic state; while, if the constant current be reversed, 1″ will become the positive pole, and the tract of nerve just mentioned will be thrown into the Anelectrotonic state. We will again employ a single Grove's cell as the source of the constant current.

I dissect out a perfectly fresh sciatic nerve with its gastrocnemius, and connect it with the machine.

Before passing the constant current through the wires I we make two tracings on the blackened cylinder, by irritating the nerve at III and at II, from which we can afterwards calculate the normal rate of conduction *in this nerve.*

That being effected I now elevate the stilette connected with the muscle, in order that the next tracings may be made upon a higher part of the cylinder, and may therefore not interfere with those which we have just obtained.

Now, we send the constant current through the nerve at İ, so that 1″ may be the negative pole, and within a minute after the closure of the constant current, obtain another pair of tracings by irritating the nerve at İĪ and İİĪ. We open the constant current and allow the nerve to rest for a minute. I again alter the position of the stilette, so that another pair of tracings may be made on a new part of the cylinder.

Lastly, we again pass the constant current between 1′ and 1″, making however 1″ the + pole in this instance.

We get another pair of tracings, and now we will print the tracings on a sheet of moistened gelatine.

Fig. 3.

The horizontal lines /, //, ///, are produced by the contact of the stilette with the smoked cylinder during its revolution while the muscle is at rest; whereas the curved lines are due to the contractions of the muscle: the first curve (o) in each pair being produced by contraction of the muscle following irritation of the nerve at İİĪ (Fig. 2), while the second curve (s) in each pair is due to irritation of the nerve at İĪ (Fig. 2). The lowest pair of curves is obtained by irritating the nerve in its normal state; the middle pair by irritating the nerve in its cathelectrotonic state; while the highest pair was obtained from the nerve in its anelectrotonic state. The distance between o and s in each pair indicates the time taken by the nervous influence to pass from the part of the nerve at İĪ (Fig. 2) to that at İİĪ (Fig. 2). You see at a glance that the distance between o and s is much shorter in the middle pair than in the other two; this clearly shows that in the cathelectrotonic state the nervous influence has travelled faster than it has done in the normal

state of the nerve: while, on the other hand, the distance between o and s in the highest pair is the greatest, showing that in the anelectrotonic state the nervous transmission has been slower than in the normal state. You see, however, when you compare the highest and lowest pairs of tracings, that the difference in the distance between o and s in each is not so great as is the difference between the lowest and middle pairs in this respect, from which it appears that the − pole, under whose influence the middle pair of tracings was obtained, has had a greater influence on the rapidity than the + pole, under whose influence the highest pair of tracings was produced. This may perhaps be accounted for by the fact that the + pole had to act on the nerve after previous excitement of the latter by the negative pole; but it may also be explained by supposing that, with a current of the strength employed by us, the − pole is more influential than the + pole. I have so often obtained a result so nearly the same as that of this experiment that I have no hesitation in saying that our conclusion must be that in the electrotonic state, induced by a constant current of medium strength, the negative pole quickens the rate at which the nervous influence is transmitted, while the positive pole slows it. This conclusion, however, is quite at variance with that at which Prof. von Bezold of Jena has arrived. According to that physiologist the rapidity of nervous transmission is diminished by both the + and the − poles of a constant current (*über die Electrische Erregung der Nerven und Muskeln*, 1861, pp. 109—155). I would not presume so decidedly to differ from von Bezold's general conclusion were I unable to account for the variance between his results and those of which you have just seen a specimen, but the explanation is, I believe, simply this, that, while von Bezold used a very strong constant current, we have employed one of medium strength. The current used by von Bezold was nearly the whole strength of that ~~divided~~ from a battery consisting of *seven* Grove's cells; whereas our current has been derived from only *one* such cell; and I believe that the Grove's cells employed by him and by us are essentially the same. Moreover, von Bezold allowed his strong current to act on the nerve *for at least three minutes* before making the obser-

vations, while we have not allowed our comparatively weak current to act *longer than one minute* before each observation was completed. That this is the explanation I feel convinced, because when I take *seven* Grove's cells and connect them with the myograph and a rheocord, exactly as von Bezold directs, and allow the current to act for three minutes ere I make the tracings, I get the same result as he obtained, viz. slowing of the rate of nervous transmission produced by the − as well as by the + pole. But the effect of such a current on a nerve is so severe that its excitability ere long disappears; indeed I generally find that after it has acted for three minutes on a nerve the excitability is considerably lowered even in the region of the − pole, and I believe that in such a case the rate of nervous conduction is lowered in the Cathelectrotonic region *because the excitability is lowered*. We know that a low temperature lowers nervous excitability, and Helmholtz has shown us that it diminishes the rate of nervous conduction, while a high temperature has the opposite effect on both; we can now therefore say that, like cold, the + pole of a constant current acts as a sedative to a nerve, diminishing its excitability and the rate of conduction, while the − pole of a current of the strength employed by us acts as a latent stimulant in increasing the excitability and the rate of conduction: and I believe that it will be found to be a law, that whatever increases or diminishes the excitability of a nerve has at the same moment a similar effect upon the rate of transmission of the nervous influence; and, indeed, so far from looking upon the *excitability* and the *conductability* (if I may use such a term, for a nerve is not simply a conductor but also a generator of nerve force) as two quite different things, as some do, I feel much inclined to think that they are essentially the same.

Our two experiments show us then that the + pole of the current we have employed lowers the nervous excitability and the rate of [illegible] conduction, while the − pole increases the excitability and the rate of conduction.

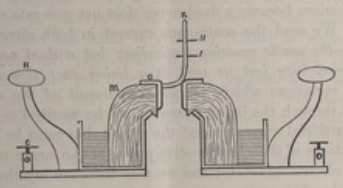
Our final experiment will be on the *Electrotonic variation of the electromotive power*.

You remember that the other day I demonstrated to you

the existence of an electrical current in living muscle and nerve, and I showed you that the current was diminished in both when they were irritated and thereby thrown into action. I will now show you the variation produced in the nervous current by the electrotonic state.

I remove the whole length of a fresh sciatic nerve. I make an accurate transverse section near its one extremity, and place that transverse section in contact with the plate of moist clay (o) (Fig. 4) on the cushion (m) of one of the galvanometer troughs (see Appendix C). I lay the longitudinal surface of the nerve (n) on the cushion of the other trough, and lastly lay the nerve upon a pair of wires / and //, connected with the same arrangements as before, for generating and directing the continuous current.

Fig. 4.



Vertical section of Du Bois Reymond's improved troughs for the Galvanometer. m. Cushion of blotting paper dipping into a concentrated solution of sulphate of zinc in the trough. o. Plate of moist clay to protect the tissues from the action of the sulphate of zinc. H. Handle to move the trough. c. Brass pillar for attaching a wire to connect the trough with the Galvanometer. n. Nerve.

As yet no *artificial* current has been sent through the nerve between / and //, and you see the slight but distinct deflection of the needle of the galvanometer which is produced by the electrical current derived from the nerve. Now we subject the portion of nerve which is generating that current, viz. that between the cushions, to the influence of the + pole of the continuous current, that is, we make / the + pole; observe, the

galvanometer needle is much farther deflected in the direction which the natural or nervous current had caused it to assume. Reverse the direction of the *artificial* continuous current, so that the nerve between the cushions will be brought under the influence of the – pole. You see the needle returns to zero, indicating thereby the diminution or even abolition of the current developed by the nerve. We repeat this experiment in an inverse order, and you see the results are the same. But you may say, Are these effects of the continuous *artificial* current not due to passage of a portion of the artificial current along the nerve, and through the coil of the galvanometer—strengthening when it passes in one direction, and neutralising when it passes in the other—the influence of the natural nervous current upon the needle? A simple experiment will settle that question. I have here a *dead* nerve. I arrange it on the cushions and the wires exactly as I did the living one: of course the needle is motionless, because a dead nerve does not generate electrical force. We send the continuous current in both directions as before—*the needle remains motionless; but a dead nerve conducts electricity just as well as a living one;* therefore the needle variations which followed the transit of the artificial current through the living nerve cannot be ascribed to passage of the artificial current round the needle, but must be referred to variations of the electromotive power of the nerve produced by the electrotonic state; and we may therefore say that while the + pole of a continuous current increases, the – pole diminishes the electromotive power of a nerve. This effect of a continuous current on a nerve was discovered by Prof. Du Bois Reymond of Berlin; and it was the discovery of this fact which led to that of the others which I have shown you.

If we now compare the results of our three experiments, we have these startling facts brought out. *In Anelectrotonus the excitability and the rate of nervous conduction are diminished, while the electromotive power is increased: whereas, in Catheleotrotonus, the excitability and the rate of nervous conduction are increased, while the electromotive power is diminished:* this is, I believe, *the law of Electrotonus.* Remember, however, that I have been showing you all along the effects of a constant

current of medium strength, and that this law is deduced from the effects of such a current. A very strong current when passed along a nerve soon kills it, and the final loss of excitability takes place first at the – pole, where the first action of the current is to increase it. It seems as though the – pole, by its latent stimulation, made the nerve *live faster*, while the + pole, by its sedative influence, causes the nerve to husband its strength.

A crowd of theoretical considerations surrounds this most interesting subject. Are the changes which constitute Electrotonus due to electrolysis of the nerve? Does the – pole increase the development of *nerve* force from chemical force, while it hinders its conversion into electrical force, and *vice versa* with the + pole? Is increased excitability of a nerve due to a higher tension of the *nerve* force, whereby its discharge is rendered more easy? and, inasmuch as increase of the excitability is accompanied by a diminution of the electromotive power, just as positive action of the nerve is, do excit*ability* and excit*ement* not stand very closely related as regards the development and expenditure of nerve force? But we have already exhausted our time, and must postpone these considerations until our next demonstration, when I will show you the facts on which are based the law of nervous irritation, or as Pflüger termed it, the "law of contraction"—that law governs the phenomena produced by the *establishment* and *resolution* of Electrotonus.

Appendix.

A. Key. The best key for closing and opening the circuit in electrical experiments is that (Fig. 5) invented by Du Bois Reymond. It consists of a plate of Vulcanite / to which are fixed two brass bars // and /// for attaching wires. Fixed to one extremity of bar /// is a short brass beam /*V* with an ivory handle. Suppose the key

included in the electrical circuit in the manner indicated in Fig. 1; as long as the brass beam *IV* remains in the position indicated in the figure, the circuit is open, for the electricity cannot pass from // to /// through the insulating vulcanite: but if the raised end of the beam be lowered so as to bring it in contact with the bar // the circuit will be closed. The friction of the beam *IV* against the bar // keeps the contiguous surfaces bright and clean, so that the very closure of the key removes any film that might impede the passage of the current. The screw *V* is used for fixing the key to a table.

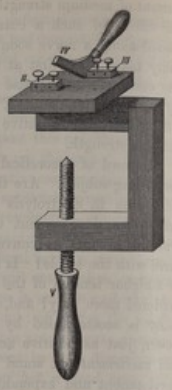


Fig. 5.

B. Helmholtz and Du Bois Reymond's Myograph.—This instrument was invented for the purpose of measuring the rate of nervous conduction, and to enable us to study muscular contraction[1].

The following is a description of the instrument arranged to measure the rate of nervous conduction—and also of the experiment, which with this instrument can only be performed, with the sciatic nerve and gastrocnemius muscle of a frog.

The instrument consists of three principal parts.

1. A brass cylinder, two inches in diameter and about an inch and a half in height, turned by clockwork, provided with a dial by which the rate of the cylinder's revolution may be ascertained with the greatest precision. The cylinder's surface is covered with glass, which is smoked before each experiment in order that a tracing may be made upon it by the point of a stilette. 2. Arrangements for holding the muscle and nerve, and for connecting the former with the stilette. The femur of a frog having the gastrocnemius attached to it is fixed in a pair of strong brass forceps; and the tendon Achilles is connected by hooks with a moveable lever having at its free extremity the stilette for writing upon the cylinder; when the muscle contracts, the lever is raised, and the stilette produces a tracing corresponding

[1] For the latter purpose it is not so well adapted, inasmuch as the lever to be moved by the contracting muscle is so heavy that the momentum it acquires in its movement destroys the finer vibrations produced by the muscle. Marey's myograph has superseded it for this purpose (*Journal of Anatomy and Physiology*, No. 1).

to the contraction. The muscle and nerve are surrounded by a glass case containing wet blotting-paper to keep the tissues moist. 3. Arrangements by which the sciatic nerve connected with the muscle is irritated at a given point of time. The nerve is irritated by the shock of an induction apparatus, produced by suddenly breaking the constant current passing from a battery through its primary coil. Two pairs of wires are placed in contact with the nerve; one pair (ÏÏ Fig. 2) as near the entrance of the nerve (*n*) into the muscle (*m*) as possible, and the other (Ï) at a part of the nerve, say two inches distant from the muscle. The wires are connected with a simple contrivance termed a commutator (see note page 88), by means of which the shock from an induction machine can be sent through the one pair of wires or through the other; the object of the whole experiment being to ascertain how long the nerve force takes to travel from the part of nerve in contact with the one pair of wires (Ï) to that in contact with the other (ÏÏ). The part of the instrument by which the electrical current is broken, and irritation of the nerve thereby produced at a given moment, consists of a round brass box fixed to the axle of the cylinder and rotating with it. The box contains a moveable weight, and as it revolves the weight by centrifugal force moves outwards, and on reaching a certain point suddenly breaks the electric circuit, and thereby induces irritation of the nerve and contraction of the muscle. By means of the dial upon the clockwork the rate of the cylinder's revolution just when the current is broken can be accurately ascertained. By means of a spiral spring attached to the weight in the brass box the rapidity with which the weight moves outwards may be regulated; we may so arrange the spring that the weight will reach the side of the box, and break the current when the cylinder is making 10 revolutions or 15 revolutions in a second, and so on. Fifteen revolutions in a second is the most convenient rate. The instrument above described is Du Bois Reymond's modification of the original instrument invented by Helmholtz. The modification consists in the arrangements for breaking the current at a given time. In Helmholtz's instrument this is effected by centrifugal balls, but the arrangement adopted by Du Bois Reymond is more compact and works with greater precision. The electrical arrangements being made the experiment is begun. 1. The velocity of the cylinder's revolution at the moment the current is broken is ascertained: let us suppose that it makes exactly 15 revolutions in a second. The circumference of the cylinder being 6 inches, $15 \times 6 = 90$ inches linear of surface of cylinder, equivalent to a second of time. 2. The cylinder's surface is blackened by causing it to revolve rapidly in the smoke of a turpentine lamp. 3. The gastrocnemius and sciatic nerve of a frog are dissected out, and attached in the manner above indicated. 4. The commutator is arranged so that the induction shock will pass through the portion of nerve near the muscle (ÏÏ): the clockwork is set in motion, and is stopped when contraction of the

muscle has taken place. 5. The machine is arranged exactly as before with this single exception, that the commutator is turned so that the induction shock will be given to the portion of nerve at two inches distance from the muscle (II). 6. The clockwork is put in motion, and the contraction of the muscle again produced. 7. The cylinder is then rolled along a thin sheet of moist gelatine, on which a print of its tracings is thereby obtained.

If the experiment have succeeded well, the print will show three tracings (see the lower third of Fig. 3). 1. A horizontal line (l) produced by the contact of the stilette with the cylinder during its revolution while the muscle is at rest. 2. A curve (o) produced by contraction of muscle when the nerve was irritated near the muscle. 3. A second curve (s) produced in the same manner when the nerve was irritated at a point two inches further from the muscle than the first point. The distance between these two curves at their commencement, that is, at their point of contact with the horizontal line—must necessarily be equivalent to the time taken by the nervous influence to pass from the part of nerve over the wires at II, to that over them at III. The two curves are, let us say, $\frac{3}{4}$th of an inch apart. What is the value in time of this interval? Ninety inches of the cylinder's surface having been found to be equivalent to a second, $\frac{1}{4}$th of an inch must necessarily equal $\frac{1}{360}$th part of a second. If the nervous influence take $\frac{1}{360}$th of a second to travel along 2 inches of nerve, how long will it take to travel 12 inches? $\frac{1}{30}$th of a second. If, then, it take $\frac{1}{30}$th of a second to pass along one foot of nerve, it will of course travel at the rate of 90 feet per second. In frogs' nerves prepared in the above manner the rate varies from 75 to 120 feet per second. The rate depends much upon the temperature to which the nerve is exposed, being slackened by low, and quickened by high temperatures. If the nerve be allowed to dry a little, the rapidity is greatly increased. The experiment should be made with perfectly fresh and healthy frogs, for when frogs have been kept long without food the nerves become so weak that the manipulation necessary for the experiment produces such excitement that the nervous influence travels with a rapidity too great for measurement by means of this instrument.

C. Troughs for the galvanometer. The porcelain troughs with the platinum plates and solution of salt, at first used by Du Bois Reymond, have for several years been superseded by another of his ingenious contrivances, viz., troughs of zinc measuring about $2\frac{1}{2}$ inches in any direction (Fig. 4). The inner surfaces of the two troughs are amalgamated, and contain a concentrated solution of sulphate of zinc. This arrangement does not give rise to the secondary currents which are so distressing when the old apparatus is used. A pad of blotting-paper (m) is folded over the side of either trough, dipping on the one hand into the saturated solution of zinc, while on the other it presents a free edge on which a thin layer of potter's clay (o) previously

moistened with a dilute solution of common salt or saliva, is laid. The muscle or nerve is always laid upon this clay in order that they may not come in contact with the corroding solution of sulphate of zinc, by which the layer of organic matter in immediate contact would be killed. These clay plates serve instead of the bladder and albumen in the old arrangement, and answer the purpose far better than these, inasmuch as they can always be made from the dry pulverised clay on very short notice, and form more perfect conductors than the other substances.

The zinc trough is fixed upon a plate of vulcanite to insulate it.

When small nonpolarisable electrodes are required, *e.g.* to examine the electrical condition of different points of a muscle or for irritating nerves when it is important to avoid all secondary currents, another arrangement of Du Bois Reymond's answers the purpose. It consists of a little glass tube, open at both ends and supported on a stand; in the tube is placed a thin strip of amalgamated zinc connected outside the tube with an ordinary conducting wire, the other end of the tube is closed with moist potter's earth drawn to a point at its free extremity; and the tube is filled with saturated solution of sulphate of zinc.

A pair of such tubes is always required,—of course the wires from the zinc plates may be connected with a galvanometer, or with a battery.

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INFLUENCE OF THE ALPINE CLIMATES von H. W

ON

PULMONARY CONSUMPTION.

BY

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MDCCCLXVII.

ON THE INFLUENCE OF THE ALPINE CLIMATES ON PULMONARY CONSUMPTION.*

THE fact that consumption does not occur amongst the inhabitants of some elevated regions is by no means new; nor is it unknown to the profession that, in some countries, the practice prevails to remove persons manifesting signs of consumption from lower localities where they have been thus attacked to higher regions. I should occupy too much space if I were to enter fully into the history of this interesting question; but I cannot forego directing attention to the important labours of Dr. Archibald Smith of Edinburgh, who has availed himself of his long residence in Lima, and in various places of the Peruvian Andes, practically to study the influence of the Andine climates on phthisis. He refers to this subject in various of his valuable papers on the Diseases of Peru,† and has quite lately‡ done me the honour to reply to an appeal for co-operation in the study of this question. § Lombard, Mühry, and Hirsch, have likewise, in their well known works, very ably treated the subject. Jourdanet has adduced important facts for Mexico, Fuchs for Germany, and Schnepp for the Pyrenees, especially for Eaux-Bonnes. The degree of elevation necessary for producing a certain degree of immunity seems to vary in different latitudes, and appears to be lower in the temperate than in the tropical regions. While, in the latter, phthisis may be regarded as becoming rare above 7000 feet, the frequency diminishes in most parts of Switzerland already above 3000 feet, and in the mountains of Central Germany already above 1400 feet. Elevation alone, however, seems not to be the only point of influence, even in the same mountain range; but there are other circumstances which assist or counteract its influence, as the degree of motion in the atmosphere; the situation of a place, either on high table-land, or on the top or on the incline of a hill, or in a valley; the configuration of the surrounding ground; the degree of exposure to the sun's rays; the aspect to the south, or north, or east, or west; the geological nature of the substratum and other conditions on which the dryness or dampness of the soil depends; the nearness or absence of large glaciers or snowfields, or lakes, or sheets of standing water; the habitual clear-

* The old term, "pulmonary consumption", is used in order to comprise not only "tuberculosis of the lungs", but also the other subacute and chronic affections of the lungs leading to consumption, which have been so well described by the late Dr. Addison, in his admirable but little known papers on the subject, in which he already, in 1838 and 1845, propounded those views which only now are gradually gaining ground.

† As early as in 1840, Dr. Archibald Smith discussed the subject in a very clear manner, in his "Practical Observations on the Diseases of Peru" (*Edinb. Med. and Surg. Journal*, No. 144); and again later, in his paper on the "Influence of the Climate of Peru on Pulmonary Consumption" (*Brit. and For. Med.-Chir. Rev.*, vol. xviii, 1856).

‡ "Climate of the Swiss Alps and of the Peruvian Andes compared." By Archibald Smith, M.D. (*Dublin Quarterly Journal of Medical Sciences*, May 1866.)

§ "Notes on the Climate of the Swiss Alps" (*Dublin Quarterly Journal of Medical Sciences*, February and May 1864).

ness or mistiness of the atmosphere; the number of clear or rainy days; the quantity of rain and snow; the degree of humidity of the air; and many other circumstances, no doubt, exercise some influence. As the Swiss Society of Naturalists has appointed a committee to inquire into the occurrence of consumption in the various parts of Switzerland, and as the same Society has meteorological stations all over the country, it may be anticipated that gradually some of the circumstances influencing or counteracting the occurrence of consumption may be elucidated.

As it has been repeatedly shown that consumptive diseases, in their earlier stages, are favourably influenced by the removal of the patient to higher elevations, it appears surprising that this plan of treatment has been almost entirely disregarded by the medical men of Europe. I will, therefore, shortly discuss the principal objections met with in conversation with men of deservedly high reputation in our profession.

1. The low temperature and the roughness of the Alpine climate during the greater part of the year are usually regarded as hostile to the delicate constitution of the consumptive patient. Cold, however, is in itself surely no cause of phthisis, which, in some of the most northern parts, is rarer than in the South of Europe. The popular prejudice against cold may, perhaps, be understood, by considering that cold induces delicate people to remain indoors, and keep their doors and windows closed, and that it often prevents the poor from gaining their livelihood; that it, therefore, gives rise indirectly to the most powerful causes of consumption; viz., confinement in ill-ventilated rooms, insufficient exercise and imperfect breathing, scanty clothing, and want of proper food. With more reason we might say, that cold in itself counteracts the tendency to consumption where there is a sufficiency of food and clothing, for it causes an increased abstraction of heat from the body, to supply which the respiratory action must be proportionately increased and the expansion of the lungs promoted, which latter is one of the greatest prophylactics against consumption.

2. A second objection often raised is, that the rarefied air of elevated localities increases the tendency to hæmoptysis. It probably owes its origin to the description of great ascents by Saussure, Humboldt, and others; but these climbers were in conditions very different from those of the invalid gently walking about near his temporary mountain residence. Those who have ascended high mountains, and especially steep snow-slopes, without being in thorough training for such work, will remember the violent beating of the heart and the throbbing of the carotid and temporal arteries, which might, one should think, easily lead to rupture of the weak vessels; yet, how rarely such a rupture actually does occur, how seldom any bleeding from the nose or mouth takes place, all those can testify who are in the habit of spending their holidays on the Swiss mountains. Some of the famous guides who constantly accompany the great Alpine climbers tell us that they have rarely, others that they have never, seen those much talked of bleedings, either in their fellow-guides or in their enterprising patrons. It may, therefore, be concluded that this supposed effect of rarefied air has been much exaggerated; but, even if it were to occur amongst active climbers, this ought not to deter the quiet invalid sojourning in elevated valleys. One of the most frequent causes of pulmonary hæmorrhage is probably the rapid breaking down of lung-tissue, and through this the lesion of blood-vessels before they have been obliterated; and circumstances favouring such a process are likely to increase the tendency to pulmonary hæmorrhage, while those unfavourable to it diminish the tendency; and I trust that such an influence may sooner or later be accorded to well selected Alpine climates.

But, apart from reasoning, let us see what experience teaches. Dr.

Archibald Smith, after having mentioned that hæmoptysis is very common in Lima, says: "Climate is supposed to be omnipotent in the cure of hæmoptysis—*i.e.*, the removal to the temperate recesses among the hills."* The recesses referred to are about 9000 feet to 10,000 feet above sea level. Again, he says, in another place: "Incipient tubercular phthisis, usually attended with more or less hæmoptysis, is one of the most common pulmonary affections known in Lima and other parts of the coast of Peru. It is a disease almost certainly curable, if taken in time, by removing the coast patient so attacked to the open inland valley of Jauja, which runs from 10,000 to 11,000 feet above sea-level."† My own experience is limited; but, amongst the invalids in whom I have been able to watch the influence of Alpine climates, there were five who, while living in low elevations, had suffered from one or more attacks of serious hæmoptysis, and all of them remained quite free during their stay in Alpine regions.

3. A third objection often raised is, the great difficulty of finding a proper mountain residence for the invalid; and this, I must confess, is not without foundation. It is impossible for an invalid in a changeable climate to live without a proper house and food, and some comforts; and it is almost impossible for him to live without society, occupation, and amusements. On the mountains of Great Britain there are, as yet, no such homes for invalids; but, in the British colonies, on the Himalaya range, there are probably many already well inhabited localities where consumptive invalids might regain their health, where the British army might have its sanatorium for the consumptive soldier. In South America, the Peruvian Andes offer many eligible situations, and especially, according to Dr. Archibald Smith, the two principal health-resorts for the phthisical invalids from Lima, Jauja and Huancayo, where the climate is temperate and equable, the sunshine bright, and fogs very rare. With the increasing facilities of communication, these Andine sanatoriums for the consumptive will become more and more accessible. The high table-land of Mexico, too, may offer many eligible localities, when once the social conditions of that country have become more settled.

In Europe itself there were up to quite lately no arrangements for the wintering of delicate persons in elevated situations; but it possesses several localities well adapted to the purpose; and in some of the valleys of the Grisons there are not only villages and inns to live in, but also trustworthy medical men to superintend the invalids. One of these valleys is the Upper Engadin, which is already well known to the profession as a summer residence, but is almost equally well suited for the reception of invalids during winter. Another but much less known valley is the Davos, at an elevation varying from 4,500 to 5,100 feet above the sea-level. It runs about eleven miles in length, parallel to the Engadin, but in the opposite direction, *i. e.*, from north-east to south-west, and is traversed by a stream called the Landwasser. Few of the mountains which border the valley on both sides exceed nine thousand feet in height, and most of them take their rise in a comparatively gentle slope, thus admitting the rays of the sun during the greater part of the day; and nowhere in the upper portion of the valley is that sense of oppression felt which dwellers of open countries often perceive in mountainous countries. The geological substratum of the valley is principally gneiss with hornblende and mica-slate; the crests on the right side of the valley consist of various formations of limestone and dolomite, which descend on some places into the valley itself, as in the neighbourhood of Davos am Platz. There are no glaciers and

* "Practical Observations on the Diseases of Peru," *l. c.*, p. 8.
† "Climate of the Swiss Alps and Peruvian Andes compared," *l. c.*, p. 349.

large snowfields in the neighbourhood, a circumstance which, though it takes away from the grandness of the scenery, increases the value of the locality as a health resort, as being less subject to those icy winds descending from glaciers and extensive snowfields. The principal village is Davos am Platz, about 5,100 feet above the sea, with two good inns situated still on the slope of a hill facing the south. Two excellent medical men reside there, Drs. Spengler and Unger, who devote themselves particularly to pulmonary affections, and keep accurate notes of the progress of the cases under their charge. Dr. Unger, to whom I am indebted for much valuable information, himself had a cavity in his right lung when he first resorted to mountainous climates, and now, after a lapse of four years, is not only free from cough, but is also able to undergo considerable bodily exertion. The population of the valley, especially the male, has the appearance of robust health, with the broad shoulders and wide chests peculiar to mountaineers; and the locality has for many years past enjoyed a good reputation for its influence on scrofulous diseases.* I am not yet provided with accurate meteorological observations, but they are being made by Dr. Spengler. The winter is, of course, cold; but this cold is not excessive, and appears to be rather less than in some lower localities of Switzerland, owing principally to the fact that the valley is protected on the north and north-east. The number of clear days is comparatively great in autumn and winter, in fact greater than in summer; and, owing to the configuration of the locality, the rays of the sun have access during the greater part of the day, and their force in the rarefied air is so great as to allow the invalid on fine winter days to sit in the open air or at the open window.

With regard to the diseases prevalent in the Davos, there are, according to Dr. Spengler's experience extending over more than twelve years, no endemic diseases. Pneumonia is the most frequent of the more serious affections, but it terminates in general favourably on the seventh day without active treatment; the lower lobes are those most usually affected, but occasionally the disease occupies the upper lobes; the termination in consumption seems to be unknown. Chronic bronchitis and emphysema are not rare, but are probably less frequent than is usually believed. Croup is a comparatively frequent disease, especially in spring. Rheumatic affections and diseases of the heart are frequent; and not less so various forms of dyspepsia, and chronic affections of the stomach, especially the round ulcer. The mortality of children is small. Scrofulous diseases originate very rarely in the valley, and those introduced from abroad are favourably influenced by a prolonged residence. Dr. Unger especially mentions the entire absence of tubercular diseases of the lungs among the natives who have never left their valley; and Dr. Spengler perfectly corroborates this statement, and has also mentioned to us cases of men who had become consumptive while working abroad, and have regained their health by a timely return to their native home. Dr. Brügger, it may be remembered, has made the same statement with regard to the neighbouring valley of the Upper Engadin; and Dr. Boner of Klosters likewise states that, in the upper part of the Prättigau, immediately adjoining the Davos, although below the level of 4,000 feet, he has not met with consumption; while it has repeatedly occurred to him in the lower part of the same valley.†

The absence of consumption and scrofulous diseases among the inhabitants of the valley who have never left their home, the influence

* Dr. Meyer Ahrens, "Die Heilquellen und Kurorte der Schweiz." Zurich, 1860, p. 709.

† I owe this statement of Dr Boner's experience to a communication from Dr Unger of Davos am Platz.

exercised on these diseases, when the natives have acquired them during their stay in other localities, by a timely return to the valley, and the usually favourable termination of pneumonia, are important facts in recommendation of the curative influence of such mountain valleys in scrofulous and consumptive diseases—facts which cannot be urged in the same manner for other localities greatly in favour with the profession and the public. I can, however, not deny that there are also disadvantages connected with a prolonged stay in these mountain regions, especially the want of the habitual society and healthy excitement, and of the accustomed comfort. I do not undervalue these disadvantages, which to some invalids are most serious drawbacks; but, if it could be proved that, in a certain class of cases, the curative influence is much greater than in the usual and more agreeable health-resorts, the profession would sooner or later declare in favour of the elevated regions, and the present disadvantages would thereby gradually be much lessened. I shall, for this purpose, give an outline of those cases which have particularly influenced me in forming a favourable view, and then add a short abstract of the observations made by Drs. Spengler and Unger at the Davos.

Case I. J. H., aged 24, a clockmaker from the Black Forest, who formerly had enjoyed good health, came to England in the summer of 1848. He had repeated attacks of sore-throat and bronchitis in the same and in the following winters, and became an out-patient of the German Hospital in the summer of 1851, with cough and dyspeptic symptoms. He had slight dulness and impaired respiration in the right clavicular and infraclavicular region; and, with slight variations, gradually lost weight up to September 1852, when he was seized with bronchopneumonia of the lower part of the left lung, slowly creeping upwards, until, in the beginning of November, the dulness reached on the back up to the upper third of the scapula; the crepitant rhonchus having ceased in the lower portion of the dull space, but being persistent in the upper. On the right, the originally diseased side, the dulness extended from the apex to the fourth rib, and was accompanied by a slight degree of bronchophony and large-sized rhonchi. There was great emaciation; pyrexia every evening, followed by perspiration towards the morning. Pulse 110 to 120; and chest-expansion 33 to 34½ inches. In this condition he returned to his home in the Black Forest, about 2,800 feet above the sea-level; where, after some weeks, on milk diet, he gained strength, lost the night-perspiration, and gradually also the cough. In July 1853, when he returned to London, nothing abnormal could be discovered on the left side. The upper part of the right was considerably flattened; but the dulness extended only from the apex to the second intercostal space; the bronchophony was replaced by absence of vesicular murmur and prolonged expiration; and there were no rhonchi. Pulse 82; chest-expansion 34½ to 36½ inches; increase in weight, 21 lbs. He remained well up to August 1854, when he again began to cough; not long after which, while at work, he was seized with violent hæmoptysis, and died on the fifth day.

Post Mortem Examination. The upper lobe of the right lung was adherent; the apex hard, contracted, consisting entirely of slate-coloured, dense, fibrous tissue, almost grating under the knife. The lower part of the same lobe was expanded, as in emphysema. The two other lobes were free from old disease; but several bronchi were plugged up with coagulated blood. The left lung was everywhere adherent. In the centre of the upper lobe was a small fresh cavity filled with blood, with grey soft infiltration in its neighbourhood. In various parts of both lobes were apoplectic nodules; several bronchi were filled with

decomposing coagulated blood. The heart was fatty. The liver was likewise slightly fatty. The kidneys were congested.

This case, which evidently was one of Addison's pneumonic phthisis, is of great interest, not only on account of the rapid recovery after the patient's return to his mountain home, but also on account of the relapse and fatal termination after the too early return into unfavourable conditions; and, further, on account of the light thrown upon the nature of the affection by the result of the *post mortem* inspection.

Case II. J. K., aged 22, a native of Switzerland, formerly healthy, came to London in 1849, and was employed as a waiter in a City dining-room. He began to cough in 1850, and had hæmoptysis in February 1852. Dulness and rhonchi extended from the right apex to the third rib. There was increase of cough and pyrexia in July. Pneumonic affection of the lower part of the left side was discovered in August. The dulness and crepitant rhonchi gradually ascended to the supraspinal region on the left side (in November); and the older affection of the right side had much extended. The patient was never entirely free from fever. Loss of weight, 30 lbs. in eight months; pulse 90 to 95; respirations 30 to 36; expansion of chest, 34½ to 35½ inches. In this condition he returned home in November to an elevation of about 5,000 feet; and there, on an almost pure milk-diet, he gradually improved, and came back to London in May 1853, having gained 24 lbs. The left side appeared normal; the upper part of the right was sunk in; but there were no rhonchi, and the dulness and defective breathing extended only to the second rib. Pulse 75; respirations 14; expansion of chest, 35 to 37½ inches.

He remained well until March 1855, when he contracted bronchitis, followed by pleuropneumonia of the right side, beginning at the apex, and extending rapidly downwards. In June, the upper part of the left side became likewise affected. Death ensued at the end of this month, from hæmoptysis.

Post Mortem Examination. There were extensive adhesions on both sides. The upper lobe of the right lung was much contracted and puckered; the apex was occupied by several chalky concretions, surrounded by dense, fibrous, slate-coloured, airless tissue. The remainder of the right lung was in a state of soft grey infiltration, with several fresh irregular cavities. The apex of the left lung was in a similar condition; but the greater part of this lung was permeable to air; it contained many hæmorrhagic spots. There were no miliary tubercles. The heart was fatty. The kidneys were in the first stage of Bright's disease.

This was again a case of Addison's pneumonic phthisis, occurring under the influence of confined air in a youth accustomed to pure mountain air. Great improvement or cure was produced by a prolonged stay in his native mountain climate—an improvement which continued for some years after his return into unfavourable hygienic conditions. At last, however, a fresh attack of catarrhal pneumonia led to rapid breaking down of tissue, the formation of cavities, and death accelerated by hæmoptysis.

Case III. H. F., aged 31, a German, came to London in 1852, had a chronic cough in 1853, and hæmoptysis in the summers of 1854 and 1856. He spent then seven months in Cairo, where he became better, without, however, entirely losing his cough. He had again hæmoptysis in March 1857 in Cairo, and much cough during the summer of 1857 in London. There was improvement during the following winter at Cannes and Nice; but he was much worse after his return to London. He was first seen by myself in July 1858. He had lost 29 lb. in three years. There was dulness on the left side from the apex to the fifth rib, with bronchophony and crackling rhonchus in the supra- and infra-clavicular

spaces; and an analogous condition on the back of the same side. Nothing abnormal was discovered on the right side. He had shortness of breath. Pulse 85; thoracic expansion, 35 to 36½ inches. He went to Valparaiso, and had there again hæmoptysis. He spent then eight months on the Peruvian Andes (at an elevation of between 9,000 and 10,000 feet), and gained flesh and lost cough. He went afterwards to New Orleans, where he again began to cough and lose flesh. He was sent thence to the table-land of Mexico, where, to his own feeling, he entirely recovered his health. When seen by me in the autumn of 1860, the dulness on the left side reached only from the apex to the third rib. This portion was much flattened; and there was absence of vesicular breathing, but no bronchophony, and no rhonchus. He had gained 24 lb. in twenty-seven months. Pulse 66; expansion of chest, 36 to 38 inches. He remained well until the spring of 1866, when he again began to cough, was often feverish, lost much flesh, and had some hæmoptysis. When seen in the beginning of October 1866, the old affection of the left side had remained almost unchanged; but on the right there was dulness from the apex to the fourth rib, with bronchophony and occasional crackling rhonchus in the subclavicular space. He had lost 20 lb. in twelve months. Pulse 95; chest-expansion, 35½ to 37 inches. He went to the Valley of Jauja, in the Peruvian Andes, and lost his cough almost entirely; and, when seen in June 1867, he had gained 15 lb. The dulness descended on the right side only to the second rib. There was no rhonchus, but scarcely any respiratory murmur over the dull space. Pulse 74; expansion of chest, 36 to 38 inches.

The rapid improvement repeatedly obtained in this case by the removal to elevated regions is very striking; and it is also important to remark, that the improvement effected by the stay at Cairo and in the South of France was neither so great nor so lasting as that from the mountain sojourn.

Case IV. B. D., from the lower parts of Switzerland, came to London in 1864, aged 22. He was much depressed by the fogs and dulness of the atmosphere. He had repeated attacks of bronchitis during the winter; and in the spring of 1865 he coughed, and became emaciated during the summer. There was slight dulness in the left clavicular and infraclavicular region, with diminished respiratory sounds. He spent the winter at Bordeaux and at Cannes; he never lost his cough entirely, and continued to lose weight. He returned to London in May 1866. Dulness extended on the left side from the apex to the third rib. He had, early in June, an attack of sore-throat, which was with him the usual forerunner of bronchitis; he became feverish, and by the end of the month a pleuropneumonic affection was ascertained in the lower part of the right side, which gradually crept upwards to the upper third of the scapula. By the end of July, the pyrexia had almost ceased, under a treatment of milk, quinine, and cod-liver oil; but the dulness over the back of the right side had not yielded. There was crepitant rhonchus over the upper part of the dull space, and absence of respiratory murmur over the lower; pulse 92 to 100; expansion of chest, 31½ to 33 inches. The dyspnœa was great at every exertion; frequent cough, with about two and a half ounces of mucopurulent expectoration. He had lost 27 lbs. in as many months' stay in London. In this state he went, towards the end of July, to the Righi (Kaltbad and Scheideck), lived there almost entirely in the open air, and drank about two quarts of milk every day. In less than six weeks, he was able to take considerable walks; and in October he had lost his cough almost entirely. He spent the winter in different parts of Switzerland, usually above 2,500 feet above the sea-level. He had not a single

attack of sore-throat and bronchitis; and when he returned to London, towards the end of May, the right side was quite normal; the left side was in front, in the supra- and infra-clavicular spaces, slightly sunk in; there was moderate dulness and scarcely perceptible breathing from the apex to the second rib. He had gained 19 lb. in weight during ten months, and felt in every respect perfectly well.

Case v. B. K., aged 21, had pneumonia of the right side about ten years ago. He came to London in spring 1865, and began to cough and lose flesh in the winter 1865-66. Hoarseness supervened in spring 1866, and the cough gradually increased. When seen in July, he was thin and pale, with circumscribed red cheeks; he had chronic swelling of the tarsal portion of the eyelids; pulse 105 to 110; respirations 26 to 30; temperature every evening slightly increased. There was fresh pneumonic affection of the lower part of the left side; dulness and absence of respiratory murmur on the right from the apex to the third rib. The evening pyrexia gradually subsided under perfect rest and milk diet; but the pneumonic affection slowly crept upwards, the dulness extending on the posterior part of the left side from the bottom to the upper third. When he left England towards the end of August, there was crepitation with slight bronchophony over the greater part of the left scapula; and the older affection of the right side had remained unchanged. He was advised to go to the Davos, but went first to Germany; and only after having been attacked by fresh colds he repaired in November to Davos am Platz, where he stayed until the middle of April, and, in spite of a rather unfavourable winter, entirely lost his cough, and gained 7 lbs. in weight; and the spirometer showed an increase of pulmonary capacity amounting to more than 900 cubic *centimètres*. According to Dr. Unger's report at the time of A. B.'s departure from the Davos, nothing abnormal could be discovered on the left side, except, perhaps, slight dulness in the lowest part; and the dull space on the upper portion of the right side was likewise diminished. In addition, the affection of the eyelids, which had existed for several years, had entirely disappeared without remedial interference.

With regard to the experience collected at Davos am Platz, accurate records date only from February 1865, when Dr. Unger, himself formerly consumptive, and then not yet quite recovered, came to the village, accompanied by a young gentleman with extensive lung-disease. Between February 1865 and March 1867, 35 patients with consumptive affections had been under the observation and treatment of Drs. Spengler and Unger, who have kindly furnished me with a report; of which, however, I can only give a very short summary. Of these 35 cases, only 1, belonging to a consumptive family, offered no distinct signs to auscultation and percussion, although the spirometer shewed a considerable impairment of the respiratory capacity. Of the other 34 cases, 19 were in the first stage, with distinct deposits; 15 in the second, with cavities. Of the 19 in the first stage, 2 had deposits in both sides, and some had other complications, as pleuritic effusion; 7 of the 19 left cured, 6 improved, 6 remained under treatment.; 18 of the 19 had gained in weight; 8 had previously had attacks of haemoptysis, which only in one of them returned in a very slight degree during the stay. Attacks of fresh colds were remarkably rare in all of them. Of the 15 in the second stage, only 2 were free from fever; 3 of them had pleuritic exudations; 5 of the 15 died (3 from gradual consumption, 2 from haemoptysis); 1 left worse than he arrived; 1 improved; 2, who had arrived with advanced pulmonary disease, are steadily improving; and 1 is regarded as perfectly convalescent. It is worthy of remark, that diarrhœa did not occur in any of them, and that the night-perspiration in almost all cases disappeared after a short stay. In

one case only, careless exposure led to a croupous pneumonia of the left lower lobe, with a favourable termination on the fifth day.

The treatment adopted at the Davos consists in the use of much milk, and light nourishing food; a moderate amount of wine, principally the red wine of the Valteline; and graduated exercise, first on level, later up hill. The cold douche is likewise in many cases used with advantage.

Those who consider the facts related will probably not deny that they offer testimony in favour of mountainous climates. The two cases which at a later period ended fatally are particularly instructive, by shewing that a curative process had taken place during the stay in elevated regions. Both cases, and probably also the three others related, belonged to the class described by Addison under the head of pneumonic phthisis. It is probably on these low forms of catarrhal pneumonia, with a tendency to chronic infiltration, cheesy transformation, and formation of cavities, that the Alpine climates have a truly curative and prophylactic influence.

The question, how the mountain climates exercise so favourable an influence, can probably not be answered without entering the field of theories, which I wish to avoid as much as possible. There are, however, some undeniable facts. Thus the air of elevated regions is lighter, more rarefied, and cooler; and it is usually free from the foreign admixtures found in towns, and also free from the various kinds of malaria. The food, the occupation, and the whole manner of living, are generally different from those prevailing in large towns and much inhabited districts. The influence observed by most people on their removal to mountainous climates is an improvement of appetite, digestion, formation of blood, and nutrition in general. Exhilaration and increased inclination to exercise are likewise frequent attendants of the change. All the influences enumerated, to which others might be added, are of importance in the consideration of the question before us. I will only allude to one; viz., the rarefied air. A given volume of air contains absolutely less oxygen and other constituents at an elevation of 5,000 feet, than at the level of the sea. The movements of the thorax must, therefore, be increased, if the same amount of oxygen is to be introduced; or a smaller amount of oxygen will be introduced, if the movements of the thorax remain the same. It has been asserted, but, as far as I know, not yet been proved experimentally, that the inspirations on mountains are deeper. Healthy persons, at all events, usually have an inclination to take deeper inspirations; and the broad chest of mountaineers may be regarded as an effect of increased respiratory movements. If this view were correct, it might be asked, how far this augmented action of the organs of respiration, and, as a necessary consequence, those of circulation, influences the sanguification and all the processes of nutrition—how far, I say, this mere increase of chest-expansion would go to explain the facts before us. All influences, climatic, physical, or mental, by which the breathing is habitually increased, appear to act beneficially in the tendency to consumption; while all those causing diminished breathing seem to favour, in man and animals, the development of scrofulous and catarrhal inflammations, and of consumptive diseases of the lungs in general.

Although I have already occupied too much space, I must still add a word of caution. Not all consumptive constitutions probably are fit for the Alpine climate, and not all the stages of consumptive disease may be benefited. The invalid ought not to be allowed to go to any Alpine climate he likes, and do there as he pleases; but he ought to be directed to a place where he can have the advice of a medical man who will carefully superintend his diet, his exercise, and his whole manner of

living. Many invalids lose the benefit obtained in the commencement by over-exercise and careless exposure; and the very help which these climates have given them may be turned by them to their ruin. It is further necessary that the invalid be sent in an early stage of the disease, and that he remain long enough, if possible, to regain the full capacity of healthy lungs; and that he be not allowed to return too early to his former unhealthy residence and occupation. On all these points, however, I cannot suggest better advice than that embodied in the excellent works of Sir James Clark on the *Sanative Influence of Climate*, and on *Pulmonary Consumption*.

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MISCELLANEOUS

CONTRIBUTIONS TO THE STUDY OF PATHOLOGY.

BY

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HAVING from time to time during the last two or three years collected material from our hospital books for clinical and pathological lectures, I propose in this series to place on record some of the cases from that source which have furnished me with a basis for my lectures.[1] I shall also incorporate with them a few other cases which have come under my own notice bearing on the subject in hand, and append allusions to any cases from other quarters which may appear specially illustrative of it. The instances of chorea which I have placed in Chapter the *First* I had already prepared and intended to have supplied (now nearly a year ago) to this Review, but postponed them on ascertaining that my friend Dr. Tuckwell, of Oxford, was engaged upon the observations which, in connection with the interesting case of fatal maniacal chorea, were published in the number for October last.[2] I propose to add, by way of short notes upon the individual cases, such observations as each one may suggest, and at the end of the chapter comment upon them as a whole.

[1] The cases which I have prepared for this series are cases of chorea, of fatal tetanus, and of fatal poisoning.

[2] I shall append to this chapter the details of a chronic but severe case of maniacal chorea in a pregnant unmarried girl, which not long ago came under my care at the hospital.

CHAPTER I.

Remarks on Chorea Sancti Viti, including the History, Course, and Termination of Sixteen Fatal Cases, and also certain details of Out-patient and other Cases which were not fatal.

Case 1.—*Chorea; pregnancy; fibrinous deposits on the heart's valves.*[1]

Anne G—, æt. 23, pregnant for the second time, was admitted July 21st, 1841, with chorea, which had been apparently brought on by a fright. She was confined forty-seven hours before death. No further particulars are recorded, except that she died August 30th.

Post-mortem examination.—Cranium.—Pia mater much congested, especially over the cerebellum; brain much congested; its ventricles of natural size, containing only a slight amount of fluid.

Spinal cord healthy; intra-vertebral veins very congested. Whole of brain and spinal cord rather softened, but this probably owing to great heat of temperature.

Thorax.—Heart's walls softened; *the tricuspid valve had, on its segments, several soft fibrinous granulations, easily removable.*

Abdomen.—The right kidney and ureter were wanting, but the corresponding supra-renal capsule was in its natural position; the bladder had only one urethral aperture; the uterus was contracted to the size of a fœtus' head; the corpus luteum unusually small, and the coats of the Graafian vesicle could scarcely be seen within the yellow matter.

Remarks.—As points worthy of notice in the history of this case, I would draw attention to the pregnant condition of the patient, and to the fright which she experienced; both being circumstances generally acknowledged as frequently instrumental in the causation of choreic affections. Amongst the anatomical characters presented after death worthy of consideration were the congestion of the nervous centres, and the condition of the heart's valves. The softening of the spinal cord need not be looked upon as other than a result of post-mortem change. The absence of the right kidney, though of course without any possible connection with the disease which the patient suffered from, is a fact worthy of notice[2] (149).

Case 2.—*Chorea; congestion of the brain; unusual amount of fæcal accumulation in and adherent to the intestines.*

Emma L—, a maid-servant, æt. 17, was admitted November 16th, 1842, with violent chorea, which had been coming on gradually for the previous fortnight. The catamenia had been absent since

[1] This case I find has been related by Dr. Robert Lee, in his "Clinical Midwifery," 1848, p. 112.

[2] We have the history of several cases in our hospital records, in which absence or malformation of a kidney existed.

August, but then was scanty. She had not been frightened and no cause of the disease could be given. The pulse was quick and the tongue coated, and thirst was complained of. She had had no medicine excepting some purgative pills. Two three-grain doses of calomel, followed by a dose of senna, were given, and a warm bath ordered. As on the next day the bowels had not been opened, the calomel and senna were repeated, also the warm bath. Two days after admission the pulse was more feeble and quick. She was quieter, though she had had no sleep, and been very violent in the night. A large-sized evacuation had followed the enema. The choreic movements rather quickly ceased, and she became comatose, and died in the middle of the following night.

Post-mortem examination.—Cranium.—Great congestion of the vessels of the brain existed; there was slight serous effusion at the base of the brain, and the outer parts of the brain were much darker than usual; the bloody puncta in the white parts were much more numerous than natural; ventricles of natural size. No other morbid appearance.

Spinal canal.—Congestion of the posterior vertebral veins existed; and slight effusion of serum in the theca vertebralis; the substance of the spinal cord was congested. No other morbid appearance.

Thorax.—The right side of the heart was gorged with blood, and slight hypertrophy of the left ventricle existed; the lungs were adherent to the chest walls. No valvular disease.

Abdomen.—The small intestines from the jejunum to the ileo-cæcal valve were filled with fæces, very tenacious, and in many parts so adherent to the bowel as only to be removed with much difficulty; the large bowel also was filled with fæcal matter; the lining of the cæcum and ascending colon very congested; the peritoneum everywhere was very congested; the uterus and ovaries were *unusually large*,[1] the former very congested, as also the vagina; the ovaria containing several cysts.

Remarks.—In this case, which followed a very rapid course, there appears to have been no history of fright or of rheumatism; neither were the heart's valves found after death to have been affected. Amongst the noticeable post-mortem appearances are the congestion of the brain and spinal cord; the remarkable loading of the small bowel with fæcal matter, unusually adherent as it was to its walls; also the loading of the large bowel, which was congested; also the congestion of the peritoneum and of the uterine organs (75).

Case 3.—*Chorea; diseased clavicle; fibrinous deposits on the heart's valves; fæces adherent to the colon.*

Mary K—, æt. 15, was admitted November 6th, 1844. She had enjoyed good health until twelve years of age, when before one

[1] Much larger than in those who have borne children.

of the catamenial periods she was attacked by chorea, commencing gradually and becoming severe, at first affecting one side chiefly, then becoming general. The movements ceased during the night. She was often drowsy, and felt pain across the forehead. The abdominal organs appeared to be natural. She got well in two months by taking tonics, purgatives, and sedatives. About two months afterwards she had a *second* severe attack, preceded by drowsiness, and recovered under the same remedies. The catamenia then appeared, were regular for eight months, and the girl enjoyed good health. Afterwards menstruation became irregular, and finally ceased; and after three months the involuntary movements returned.

She came into hospital with slight chorea, which increased, coming on in paroxysms, leaving great exhaustion. She died, quite worn out, November 24th. Before death she complained of pain like rheumatism about the left wrist and the right side of the chest.

Post-mortem examination.—Cranium.—The brain was wet, otherwise it was natural.

Spinal canal.—The veins of the cord were much congested, otherwise the cord was quite natural.

Thorax.—The clavicle was denuded of periosteum, having an abscess under the pectoral muscles in connection with it; the lungs were condensed posteriorly; *fringes of fibrine-coagulum were found on the auricular side of the mitral valve curtains.*

Abdomen.—Much light-coloured fæces were found adherent to the inner surface of the colon, otherwise the abdominal contents were natural; the generative organs were vascular.

Remarks.—In this case the recurrence of the malady three times (with distinct intervals) is to be noticed; the two first attacks, at any rate, appearing to have some definitive relation to the uterine functions; also the headache and tendency to drowsiness, and after death the congestion of the spinal cord; also the condition of the heart's valves. The abscess about the clavicle appears to have been unnoticed during life (258).

CASE. 4.—*Chorea; congestion of the brain; fibrinous deposits on the heart's valves.*

Mary H—, æt 26, a married woman with two children, the youngest being æt. 4, was admitted January 8th, 1845. She had complained of pains in the head since her last confinement; shortly afterwards she had twitchings and jactitations of the left side, generally not severe, but sometimes so sudden as "to take her off her legs." The movements were worse when the headache was bad, and also worse when recumbent. She had had rheumatic fever two months previously and recovered, and about ten days afterwards she was suddenly thrown down in the park by sudden jactitations on the

right side of her body. These then gradually affected the other side of the body and increased.

Some days before admission she had had no sleep, and had dysphagia. For a long period she had had hæmorrhage for a week at a time every fortnight.

When admitted the face was flushed and hot; jactitations were violent all over the body equally, and she could hardly speak or swallow. She was quite sensible, and complained of pain in the head; the pupils acted readily; the pulse was frequent, but almost imperceptible. The tongue was coated; the bowels open.

Fetid gums were ordered, and ordinary diet and porter given.

On the day following pain in the head was very bad. Calomel and opium were given every four hours, and a turpentine enema administered; the head was shaved and ice applied. The bowels acted twice after the injection. She slept in the night a quarter of an hour, and then the jactitations ceased; they again came on when she awoke. The calomel and opium were repeated.

On the 10th the pulse was 140; she slept in the night, and on the following morning (the 11th) she was noticed to be drowsy. The calomel and opium were omitted; she became exhausted, and the pulse much slower and weak. She sank and died the same day.

Post-mortem examination.— Cranium.—The scalp vessels were gorged with blood, as also the meningeal veins. The cerebral membranes were healthy. The grey substance of the brain was dark, and the puncta large and numerous. The pons Varolii and medulla oblongata were very congested. Their substance was firm.

Thorax.—The lungs were congested posteriorly. *Slight fibrinous deposit existed round the mitral orifice of the heart on the auricular surface.*

Abdomen.—The uterus was large and hard, and its cervix could hardly be cut, but no scirrhous deposit was met with. The neck and lips of the uterus were much, but superficially, ulcerated. Extravasated blood existed in the ovaries, in cysts.

The other organs were healthy.

Remarks.—Notice in this case the pains in the head, to which treatment was directed, the existence of dysphagia, and the previous existence of rheumatic fever. After death the congestion of the nervous centres (the spinal cord unfortunately being not examined), the state of the heart's valves, and the condition of the uterine organs are noticeable (10).

CASE 5.—*Chorea; areolar tissue inflammation and erysipelas; abscess of the mediastinum, and empyema.*

Anne M—, æt. 17, was admitted October 15th, 1845. Six or seven months previously she had had a fright, which deprived her of movement or speech for a quarter of an hour, and afterwards she had

symptoms of chorea, with twitching of the muscles of the face and upper limbs. Catamenia absent ever since. She had ascarides. There had been no previous attack of chorea.

On admission the face was flushed, the movements very troublesome; the heart's sounds were natural, but its action was quick; breathing natural but hurried.

Iron and purgatives were given, and morphia subsequently to procure sleep.

A swelling existed on one of the wrist-joints from frequent movements, and there was soreness of the back and limbs. The symptoms of chorea were almost instantly relieved by a water-bed following a warm bath, but she complained of a "pricking pain" at the heart, and a loud bruit came on *with both cardiac sounds*—at the apex loudest with the first sound, loudest at the base and downwards towards the aortic valves with the second sound.

Calomel and opium, and afterwards quinia and belladonna, were administered.

October 31st.—It was noted that the chorea had almost ceased, the chest symptoms increasing. Dyspnœa was oppressive; there was short cough, and expectoration; the pulse was irregular and quick; the fingers almost constantly flexed, thumbs drawn into the palms.

November 3rd.—So weak as to require stimulants.

5th.—The heart's bruit had *disappeared*, but the left side of the chest was dull, and not rising on inspiration. She became worse and dyspnœa increased.

7th.—Erysipelas of the ankle set in, and she became weaker until she died; a slight return of chorea came on two days before death, which occurred November 12th.

Post-mortem examination.—Sloughs on the surface, and erysipelas.

Thorax.—An abscess was found in the anterior mediastinum, and pus in the left pleural sac. The lungs were compressed, and without air. The heart was healthy in all respects.

Cranium.—The brain was natural.

Spinal column.—Much fluid existed in the arachnoïd cavity of the spinal cord; otherwise the cord was natural. A small abscess existed in connection with an intervertebral cartilage just below the diaphragm.

Remarks.—Notice in this case the fright as the assigned cause, and absence of catamenia since the commencement of the attack. The abscess of the mediastinum and the empyema were probably of pyæmic origin, and connected with the bed-sores. Unfortunately, the wrist-joints were not examined after death. The *disappearance* of the cardiac murmurs must not be disregarded (261).

CASE 6.—*Chorea; liability to rheumatic fever; old pericarditis; fibrinous deposit on the heart's valves. Softening of the spinal cord.*

George S—, æt. 19, was admitted June 27th, 1850, unable to stand or walk. It was stated that he returned from work on the 20th complaining of pains in the knees, which had since then swelled. He had had several attacks of rheumatic fever since he was twelve years old. On the 24th involuntary movements of the hands and legs had begun, and had increased ever since. On admission the movements were very decided, but not very frequent or severe, and there was a vacant and painful expression of face. The heart's action was excited and its sounds nowhere very distinct; a well-marked bruit existed at the point where the apex was felt beating. The urine was very loaded, bowels relaxed, tongue whitish. He was ordered half a grain of tartar emetic every four hours, under which the movements became much controlled. He put out his tongue without much difficulty, but the painful, almost sardonic, countenance continued. On the evening of the 30th he became more restless, and at times delirious; he answered questions with more difficulty, and the choreic movements became more frequent. He had to be placed on a water-bed to prevent the evil effects of friction. Calomel and opium were given, but he became worse, and would at times almost jerk himself out of bed. For two days he was passing his evacuations involuntarily. He quickly emaciated, and sank and died July 4th.

Post-mortem examination.—*Cranium.*—The sinuses of the dura mater and the cerebral and meningeal vessels were full of blood. The brain was tolerably firm throughout, but very congested, the "puncta vasculosa" being very large and many. The ventricles were nearly empty.

Spinal canal.—The spinal veins were very distended with blood. The whole spinal cord was rather softer and more moist than natural, and opposite the third or fourth upper dorsal vertebræ it was completely broken down and almost diffluent.

Thorax.—The pericardium was universally and firmly adherent. The left ventricle of the heart was firmly contracted; its other cavities contained small coagula. *The margin of the left auriculo-ventricular opening was fringed with a row of beads of firm fibrine.* The other valves were healthy. Both lungs were loaded with blood, and their bases contained patches of hæmorrhage.

Abdomen.—The various organs were natural.

Remarks.—Observe the tendency to rheumatic fever, and the existence of the cardiac bruit, also the delirium. Among after-death appearances the softening of the spinal cord, the state of the heart's valves and of the pericardium, and the hæmorrhage into the lung are to be noticed (113).

CASE 7.—*Chorea; apparent softening of portions of the spinal cord.*

Mary W—, æt. 17, was admitted with chorea November 24th, 1855. She was emaciated, and had never menstruated. She had been quite well until five or six days previously, when she experienced slight jerkings of the limbs, which gradually increased in frequency and severity. There was no history of any fright, and she had never had any "fits." Her complexion was flushed. The tongue was moist and fissured. The pulse was full and soft, and the skin warm. At times the jerking was absent for a period of the day, but returned at night. She was perfectly rational. Morphia at night was prescribed, and four grains of sulphate of zinc every six hours, which was subsequently increased. Two days after admission she was talking incoherently and in a hysterical manner, and she refused to take medicines. She became exhausted by the constant jactitations, and chloroform was exhibited, which speedily acted, and for a time quieted her; but the movements again returned, and the chloroform was again required.

At 10 a.m. on the 28th she became stertorous and the breathing hurried; absence of all movements ensued, and she sank and died in two hours.

Post-mortem examination.—Cranium.—The bones were natural, and the brain and its membranes were quite healthy.

Spinal column.—The bones were natural; the central parts of the dorsal and the upper parts of the cervical portions of the cord appeared to be somewhat softer than they ought to be; otherwise nothing of note was found.

Thorax.—The heart and lungs were healthy.

All the other parts of the body were natural.

Remarks.—In this case there is no mention of fright as a supposed cause. The catamenia were defective. The case illustrates the relationship of the affection to, or its coincidence with, hysteria, and to a certain degree the periodicity which pertains in some instances. The sudden stertor which came on, and after death the softening of the spinal cord, are to be observed; also that the brain was natural (309).

CASE 8.—*Chorea; abscesses beneath the integument.*

Mary A. R—, æt. 7, was admitted with chorea, October 10th, 1860. She was a delicate-looking child, and very irritable, and had always been considered nervous and excitable.

Three weeks before admission she had been pushed into a ditch and greatly frightened. She remained greatly excited, and ten days afterwards she became affected by choreic movements in the limbs of both sides; the speech also became embarrassed. The bowels had been confined. The tongue was furred. The sounds and impulse of the heart

were natural. An enema was administered, and antimonial wine with nitrate of potash given in solution, and ordinary diet prescribed.

At the end of about a week nausea and vomiting were produced, and the spasmodic movements were less violent. Sulphate of zinc and valerian were subsequently given, but apparently without advantage; to this sulphate of iron was added. Friction of the hands had been so great that the skin was to a great degree rubbed off, and the hands had to be fastened down. Subsequently the choreic movements were constant and no sleep was procured. Opium and antimony were given every four hours; later on an abscess was formed under the integuments of the chest, near the shoulder. This was opened by means of poultices. Wine and bark were ordered.

At the beginning of November redness of one heel was observed, and an abscess at that place eventually formed. The abscess on the thorax also discharged blood, and she became very low, with sordes on the lips. She sank and died November 6th, the choreic movements having continued to the last.

Post-mortem examination.—Cranium and spinal column.—The brain and its membranes, as also the spinal cord and its coverings, were natural.

Thorax and abdomen.—There was a large cavity over the pectoralis muscle, extending into the axilla from the clavicle to the seventh rib. The lungs were very void of blood. The heart was natural. The abdominal organs were natural.

An abscess also existed over the fibula, near the ankle-joint.

All the tissues of the body were very pale.

Remarks.—In this case a history of fright is given. The abscesses under the integuments are to be noticed. The nervous centres were natural (295).

CASE 9.—*Chorea; death after coma and convulsions, following an attack of scarlet (?) fever; plugging of the carotid artery by fibrine.*

Edith S—, æt. 11, was admitted into the hospital October 23rd, 1861, with slight chorea, affecting chiefly the *left* side (of three weeks' standing), which was said to have followed a quarrel in which she was engaged. Her general health was good; but her father had been subject to epilepsy, and had died of aneurysm. The bowels were much loaded, and she was purged and treated by generous diet and stimulants. After a time fever and sore throat (*? scarlet fever*) came on, but without any eruption on the surface, and was attended by an albuminous state of the urine. An epileptic attack came on, and death shortly followed (Nov. 29th).

Post-mortem examination.—Cranium.—The brain was anæmic; there was no excess of ventricular fluid. The carotid artery in the cavernous sinus, on the left side, as far as the origin of the ophthalmic artery, was full of firm fibrinous coagulum.

Neck and thorax.—The heart and other organs were natural, except that the trachea was lined by soft, fibrinous exudation, the heart's cavities being full of yellow blood-coagulum; an abscess existed in the neck about the cervical glands.

Abdomen.—The kidneys were large, congested, and dripping with blood.

Remarks.—Whether the plugging of the carotid artery in this case was the result of embolism is uncertain. Possibly some fibrinous deposit may have existed on the heart's valves or lining, and been overlooked; or it may have once existed during life, and been removed before death[1] (288).

CASE 10.—*Chorea following scarlet (?) fever; congestion of the brain; fibrinous deposits on the heart's valves; recent pericarditis.*

Ann H—, æt. 9, was admitted March 5th, 1862. She had had chorea two years previously, following a fright, which quite yielded to treatment; and she went on well until November, in 1861, when she had what was called *scarlet* fever, and since then had had pains in the limbs and ankles, which had latterly been worse. Ten days before admission the chorea again came on, preventing sleep for several nights; when admitted the tongue was coated, and the pulse 76; urine turbid and scanty; a loud systolic bruit existed at the apex of the heart; the choreic movements were most severe, and she ground her teeth loudly; if the movements ceased at all she would often scream.

Purgatives, iod. of potass., bark, and morphia at night, were ordered.

No improvement occurred, and on the 7th she passed no urine; on the 8th one sixteenth of a grain of strychnia was given every six hours, and during that and the next day some diminution of convulsions occurred, but bed-sores owing to friction began to form. She became very low, and wine had to be given with quinine, in addition to morphia at night. The strychnia was omitted. The movements became less as she became weaker, and she died March 14th.

Post-mortem examination.—Thorax.—The lower parts of one lung were hepatized. *The inner surface of the mitral valve flaps was beaded with recent blood-stained fibrine.* Slight indications of recent pericarditis existed.

Abdomen.—The kidneys were vascular; other organs natural.

Cranium.—The vessels on the surface and in the substance of the brain were very full of blood; the brain otherwise natural.

Spinal cord.—Flakes of red coagulum were adherent to the side of the spinal dura mater (supposed to be of post-mortem origin), and the neighbouring veins very full of blood. The inside of the dura mater was of a dull red colour, but quite smooth and shining; the

[1] This case has been related by myself in connection with the plugging of the carotid vessel in the number of this Review for October, 1865 (see page 499).

pia mater and cord itself were natural.[1] Numbers of small recent blood clots were met with beneath the periosteum covering the central parts of the bodies of all the dorsal vertebræ, and were seen on removing the spinal cord.

Remarks.—Notice the history of a previous attack of chorea from fright, the existence of so-called scarlet fever (? rheumatic), followed by pains in the limbs, preceding this, the second attack. Notice also the cardiac bruit, and after death the condition of the heart's valves, the fulness of the cerebral veins, the blood coagulum adherent to the dura mater and beneath the periosteum of the vertebræ. The spinal cord itself and brain were natural (71).

CASE 11.—*Maniacal chorea; epileptic attacks. Fibrinous deposits on the heart's valves.*

Mary A. M—, æt. 20, and a married woman, was admitted June 14th, 1862. She was a barmaid, and had had rheumatic fever in the winter previous, and had been ailing subsequently. She had also had two "fits" since. For five days before admission she had had chorea, and for three days but little sleep. When admitted she was in an excited state, and in something like an hysterical condition, in addition to the chorea. She was treated with zinc and valerian and iron. These movements could for a time be partially controlled by suitable stimulants. On the day following she became decidedly maniacal; but after taking several quarter-grain doses of tartar emetic, from which she vomited, she became quieter. On the next day she was again sensible, but the choreic movements continued. In the evening she had an epileptic attack, and again became violent. She soon sank, and died June 17th.

Post-mortem examination.—Cranium.—The cerebral veins were full of blood, and the grey matter of the brain very dark and containing many puncta.

Spinal column.—The cord was very vascular on its surface and in the substance of its grey matter, but was otherwise natural.

Thorax.—Much recent fibrine existed, fringing the mitral valve flaps of the heart, which were also much thickened. The other organs were natural.

Abdomen.—In the ovaries were several cysts containing blood. The cervix of the uterus was congested, and presented an appearance thought to be from ulceration:[2] Fallopian tubes containing pus-like fluid.

Remarks.—In the life history of this case notice the attacks of an epileptic character which had existed previously, and which recurred shortly before death; also the hysteria-like condition in which at

[1] This case has been related at length in the 'Lancet,' May 17th, 1862; see p. 515.

[2] The uterus and ovaries are preserved in the St. George's Hospital Pathological Museum. See 'Catalogue,' series xiv, No. 5.

one time she was. As points of pathological anatomy, the congestion of the brain, the congestion of the uterus and the cysts of the ovary, as also the state of the heart's valves, are to be regarded (164).

Case 12.—*Chorea; nervous centres congested, fibrinous deposits on the heart's valves.*

Jane G—, æt. 16, was admitted May 27th, 1864, having been suffering from chorea three weeks, attributed to a fright. The catamenia were absent two months, and during that time she had complained of rheumatic pains and had some redness of the joints. On admission she was very thin, having been but imperfectly fed, owing to the chorea. Articulation was impossible; respiration very rapid, and loud râles existed in the bronchi. Wine and nourishment, and morphia with tartar emetic, were ordered. The muscular movements became more extreme, and she died in the evening of the day of admission.

Post-mortem examination.—Cranium.—The veins on the surface of the brain were full of blood, and the brain-substance very congested.

Spinal cord.—The vessels of the cord and its membranes were very congested. On section the grey matter of the cord was darker than usual, and covered with points of blood.

Thorax.—The right lung was partly hepatized. *Recent fibrinous beads existed on the mitral and aortic valve flaps of the heart, which was otherwise natural.*

Abdomen.—The spleen contained white specks of matter like tubercles; the kidneys were congested.

Remarks.—Notice the fright mentioned as the assignable cause, and after death the congestion of the nervous centres, and the state of the heart's valves (132).

Case 13.—*Chorea; congestion of nervous centres.*

Mary C—, a well-grown girl, æt. 15, was admitted June 30th, 1863, with violent choreic convulsions, affecting chiefly the upper limbs. These movements could for a time be partially controlled by placing the arms over the chest, and when she was steadfastly gazed at in the eyes. The tongue was much affected, and she could only speak in a monosyllabic cry, which could not always be understood. The power of swallowing was pretty good. Her expression was anxious, and her eyes often suffused with tears. The pupils were natural; the heart's sounds and movements were natural.

It appeared that, seven months previously, she had lived in a hard place, and was awakened often by shouting into her ears. This had much frightened her, and she left her situation, but had ever since been subject to twitchings of the muscles, and was by others considered "very nervous." The catamenia had appeared seven months back, and only once since, and then only very scantily.

No good arose from the use of sulphate of iron and zinc with sulphuric acid, and she was then ordered half a grain of tartar emetic in a morphia draught every four hours. Sleep came upon her at times, but never lasted long. The urine passed freely. Wine was given and the medicine continued.

On the 3rd a very restless night was reported, and the pulse was 150, and weak.

The movements only ceased a short time before death, July 4th.

Post-mortem examination.—The body and limbs were well nourished and healthy looking; excoriations of the skin over the gluteal regions and ankles existed.

Cranium.—The white substance of the brain contained many puncta, and the large blood-vessels in the ventricles were very distended; the corpora striata and optic thalami were natural.

The pons Varolii was very full of blood, giving a pink colour to the tissue, chiefly the anterior parts. The medulla oblongata was of a pink colour.

The cerebral dura mater was congested.

Spinal cord.—This was very vascular, and particularly the grey matter, and the vessels of the pia mater were large and full of blood.

Thorax.—The heart's cavities were uncontracted; its walls blood-stained, and the contained blood very fluid, otherwise nothing was noticeable in connection with it.

Abdomen.—The os uteri and vagina were bathed with pus, and showed evidences of mechanical irritation, the os uteri being also very open. The uterus and appendages were very full of blood; other organs natural.

Remarks.—Observe in this case the peculiar and exceptional manner in which the chorea movements were under voluntary control, as also that "fright" was the supposed cause of the attack; after death mark the congestion of the nervous centres, and the extreme irritation of the urinary organs (167).

Case 14.—*Chorea; altered state of the spinal cord; fibrinous deposits on the heart's valves.*

Leopold L—, æt. 11, was admitted July 13th, 1864; he had been an in-patient with chorea, but was discharged, still suffering to some degree. The symptoms never left him, and in three weeks he returned (the disease having lasted three months, and no cause having been ascertained for it). The whole body, which was well nourished, was affected with the movements. After the use of sulphate of zinc and iron the movements became less marked, the appetite continuing fair. He subsequently relapsed, and strychnia was given (gr. $\frac{1}{16}$th up to $\frac{1}{12}$th) along with iron; still he became worse, began to emaciate, and arsenic was substituted for the other

medicine. The surface of the body was frequently torn with the boy's nails, and the tongue often bitten. The lips became very parched and deeply and remarkably cracked and fissured, and the motions passed involuntarily. The severity of the convulsions prevented his being lifted out of bed, and in consequence a "water-bed" was resorted to. There appeared to be also great excitability and passionateness of temper, and to some degree the paroxysms could be controlled by speaking sharply to him. He had at last to be tied down, so great were the struggling and kicking; and the hair of the back of the head became worn off. The mouth and tongue became deeply ulcerated. Belladonna and other remedies were tried in vain. He sank and died from exhaustion, retaining consciousness to the last.

Post-mortem examination.—Cranium and spinal column.—The surface and also the other parts of the brain were generally injected. The ventricles were natural. The veins within the spinal column were very distended with blood, as well those lining the spinal cavity as those of the dura mater and those covering the spinal cord itself. On section the cord did not at first present any unnatural appearance; but on minute examination portions of the grey matter were of a duller and more yellow colour than natural, and this was chiefly so towards the upper part of the cord.

Thorax.—The right pleura contained a few adhesions. The left ventricle of the heart was contracted. *Upon the inner edge of the mitral valve was a line of soft beads of fibrine, easily detached.*

The kidneys were much congested; the other abdominal organs were natural.[1]

Remarks.—The congestion of the brain, the diseased state of the spinal cord, and the condition of the heart's valves are to be noticed in this case (249).

CASE 15.—*Maniacal chorea, pregnancy, intestinal worms, congestion, and softening of nervous centres, fibrinous granulations on the heart's valves.*

Harriet S—, æt. 17, a general servant, was admitted under my care, April 24th of the past year (1867), with well-marked but not severe Saint Vitus's dance, affecting the whole body, which she had suffered from since about Christmas. The catamenia had been absent three months, but before that had been regular; she had never had rheumatism. She had had measles the previous summer. She was reported also to have vomited worms of the size and shape of earth worms. She was very violent in temper, and whilst in the hospital showed this considerably. The abdomen was very large, and evidently contained a pregnant uterus; this was confirmed by the ful-

[1] This case was related by myself in the 'Transactions of the Pathological Society,' vol. xvii, p. 421: and the fissured state of the lips, illustrated by a woodcut.

Illustration referred to in CASE 14.

ness of the mammæ, and the well-marked dark colour of the areolæ of their nipples, which were found to exist. The face was rather flushed, and the patient was evidently greatly distressed in mind about her pregnancy. The heart's action was quickened and irritable, and a systolic bruit existed. The pulse was regular, but feeble. The urine was free from albumen and sugar. Bowels confined; the pupils were *not* quite of equal size, but acted tolerably well to the light. Calomel and jalap were at once given, and subsequently the mistura ferri co. with valerian thrice daily, and one third of a grain of the extract of cannabis indica ordered every night. In the course of the evening of the 29th it was found requisite to give her morphia, as she had become more violent, and as this increased, in the middle of the night she had a quarter of a grain of acetate of morphia, and one sixtieth of a grain of sulphate of atropine injected subcutaneously. She had to have the jacket applied. The violence of the choreic movements continued unabated, and sordes were formed on the lips and tongue; she also screamed much and was evidently highly delirious. The injection was repeated May 1st, and at 4 p.m. the same day she vomited a lumbricus. She became more furious and maniacal, and more exhausted, and died in the evening, twenty-four hours after the disease had become so much worse.

Post-mortem examination.—The body generally was well nourished, the surface generally congested.

Cranium.—The cranial bones were natural; the cerebral membranes were much congested; the brain itself was "wet," and pitted on the surface; the "puncta vasculosa" being increased, and giving to the brain generally a pink hue. No fluid existed in the ventricles, and, moreover, the central parts of the brain were much softened, and easily broken down by water falling upon it. The veins at the base were much congested.

Spinal column.—The vertebræ were natural. The spinal cord was hardened in chromic acid solution, and subsequently examined *microscopically* by Mr. Lockhart Clarke, who reported upon it as follows:—In the cervical and lumbar portions of the spinal cord no appreciable alteration of structure was discovered; but in the lower part of the dorsal region, at the ninth dorsal nerves, the anterior columns were swollen, and formed a convex protuberance of considerable size. In a transverse section of the cord carried through this part, and examined under the microscope, it was very evident that extensive morbid changes had been going on, the white substance had been softened, and was now very friable under the action of chromic acid. In two or three places there were circumscribed effusions of blood, surrounded by granular exudations, which had probably occurred before the effusions.

Thorax.—The left lung was very greatly gorged with blood in patches—it however floated in water. No tubercular deposit existed. The bronchial tubes were congested, and contained much

mucus; the lower lobe of the *right* lung was in the same state. The left ventricle of the heart was contracted and empty, the right one partially contracted, and containing a decolourised clot. The structure of the heart was firm; the mitral valve-flaps were slightly thickened, and on the auricular surface of the orifice some *beads of soft fibrinous deposits of recent origin and easily removeable existed*; the other valves were natural.

Abdomen.—The liver was congested; a small fibrinous deposit existed in its right lobe, which was slightly fatty; the spleen was soft. Both kidneys were coarse, and congested, and mottled. The intestines were natural with exception of containing one ascaris lumbricoïdes in the duodenum. The uterus contained a fœtus of about four months' period.

Remarks.—In this case we have the very unusual conjunction of four conditions which are separately apt to be looked upon as having a close connection with chorea, viz., the presence of intestinal worms, the pregnant condition, the anxious state of mind consequent on the concealed pregnancy, and fourthly, the heart-affection. The case passed through a very rapid course, and its complication with mania is worthy of note. The absence of rheumatic history is to be regarded. Amongst the pathological conditions ascertained after death the congestion of the nervous centres and the condition of the heart's valves are particularly noticeable (118).

Case 16.—*Chorea; sudden congestion of the lungs; effusion into the pericardium; fibrinous granulations on the heart's valves.*

Mary A. G—, æt. 12, was admitted under my care, October 3rd of the past year (1867), with slight chorea of about six weeks' duration. She was pale and anæmic, but it was affirmed that she had never been laid up with rheumatism. A very decided rather loud and rough cardiac bruit existed, attending both the systole and diastole, and heard both at the base and apex; not particularly conducted along the large vessels.

Auscultation showed nothing unnatural about the lungs.

She was at first treated by steel in various forms, and frequently purged, and santonine was twice given in hopes of evacuating any lumbrici. She was going on much the same, when dyspnœa came on suddenly December 3rd, and the right lung became full of moist sounds. She was confined to bed, and small doses of morphia and antimony were given every four hours. On the day afterwards she had greatly improved, and was in all respects much better. The antimony was continued.

She went on improving until the 20th, when vomiting came on, and the dyspnœa and the heart's action and the pulse were greatly increased, the cardiac bruit being much intensified. Congestion of the lungs set in, and she suddenly died early on the 26th.

Post-mortem examination.—*Cranium.*—The bones were natural. The cerebral membranes were natural, but the brain itself was "wet" and anæmic; otherwise it was natural. The large vessels at its base contained much dark, only very slightly decolourised and well-adherent blood-clot.

Spinal column.—The vertebræ were natural. The spinal cord was placed in a solution of chromic acid for future examination. I have later on to give the results.

Thorax.—The lungs were very loaded with serum and somewhat solidified. *The pericardium was quite full of clear serum.* The left ventricle of the heart was contracted and empty, the right one dilated and full. Around the margin of the mitral valve orifice on the auricular surface a *number of beads of soft recent fibrine were found adherent, forming a distinct ring round the edge of the orifice.* A similar ring of fibrinous beads was met with around the *right auriculo-ventricular aperture.* Similar deposits were also found on the *surface of the endocardium* in several parts. The structure of the heart was natural.

Abdomen.—The liver was fatty and nutmeggy, and greatly congested; the spleen was natural; the kidneys congested.

Remarks.—In this case observe the absence of rheumatic history, the condition of the heart as ascertained during life and after death, the suddenness of attack of lung symptoms, the unexpected death. It is noticeable that the brain showed no signs of congestion (305).

Reviewing the above sixteen cases, I will now proceed to indicate certain points, suggested by their consideration, connected with that form of chorea[1] of which they are illustrations.

First of all as regards the sex of these cases. It is generally acknowledged that chorea much more affects the female than the male sex.[2] This will be amply exemplified by the details of the cases of non-fatal chorea contained in the tables given later on; but among the above-detailed fatal cases this preponderance in favour of the female sex is remarkable, inasmuch as, out of the sixteen cases, we have no less than fourteen that were females. It is interesting to find that the late Dr. Bright observed that the *acute* form more affected females than males. Trousseau observes that the *rare* instances of chorea affecting persons after the age of puberty have almost exclusively occurred in women.

As to age, these fatal cases occurred in individuals presenting, on an average, a greater advance of life than is generally given for all cases (including fatal and non-fatal) of this variety of chorea, as

[1] I shall have the opportunity of describing one or two cases later on of other forms of chorea (not the St. Veit's dance proper) which have come under my notice.

[2] In Dr. Bright's experience males were more affected by chronic chorea than females.

we shall see in connection with the table of my out-patient choreic cases; for out of the sixteen fatal ones only two were under the age of ten (viz., Cases 8 and 10, which were respectively 7 and 10 years of age), whilst three were of the age of 20 and upwards (viz., Cases 1, 4, and 11), the rest being intermediate—two being aged 11, one aged 12, two aged 15, one aged 16, three aged 17, and one aged 19. The extent to which age, sex, and other so-termed predisposing causes may favour attacks of chorea, will be more fully alluded to when my non-fatal cases of chorea shall have been given in an ensuing Number.

As regards the LENGTH OF TIME during which the patients had suffered from the affection before it proved fatal, it will be found that of those whose history contains information on this point, this period was, on the whole, a short one; for though in the case of one (viz., No. 13) it was possibly seven months, in another (No. 5) six or seven months, in two others (No. 14 and 15) three months, in another (No. 8) six weeks, in another (No. 16) nine weeks, in two others (Nos. 10 and 12) three weeks, in No. 2 two weeks; yet in No. 6 it was only ten days, in Nos. 7 and 10 only ten days, and in No. 11 only eight days.

As regards the fact of the patients having suffered from PREVIOUS ATTACKS of chorea or not, in only three cases have we mention of this—viz., in Case 3, in which two previous attacks occurred; in Case 10, in which one previous attack had existed; and in Case 14, wherein a relapse was suffered while the patient was in the hospital. Speaking of this well-known tendency to relapse, Romberg quotes a case in which a girl aged 9 had nine relapses, with intervals of about one year.

The details of my cases are not sufficiently explicit to show which parts of the body were, in various instances, chiefly affected.

Respecting so-called important COMPLICATIONS of the affection, it will be seen that in Cases 3 and 4 *headache and drowsiness* had been suffered. (Of course, I exclude in such complications the headache, &c., which might attend the effects of opiates and other remedies, and which might also result from exhaustion, pain, want of sleep, &c.) In one case (No. 11) *epileptic* attacks had existed; in one case (No. 9) chorea and *convulsions* followed an attack of scarlet fever; in two cases (7 and 11) *hysteria*-like symptoms; and in Case 6 *delirium* existed. In this latter case, also, the *sphincters* were mentioned as having been affected.[1] In Cases 11 and 15 (one a married woman, aged 20; the other aged 15) *mania* existed. It may here be worthy of mention that authors speak of a connection between chorea and other so-called neuroses. For example, Dr.

[1] Jules Simon observes that in chorea the sphincters may be also affected, or rather that the fæcal matter is propelled by the contractions of the abdominal and visceral muscles. This would appear to be so at any rate in those cases in which there is inability to retain the urine, a somewhat rare occurrence.

Theophilus Thompson, in his article on this disease in 'Tweedies' Library of Medicine,' alludes to chorea as being, at puberty, superseded by hysteria, and this by neuralgia, seeming to depend on a similar condition of the nervous system; he also refers to chorea as inducing fatuity, epilepsy, or hemiplegia. Dr. Bright thought an analogy could be traced between chorea and other diseases of the nervous system, marked by general irritability, and remarks, "Thus, I am induced to point out a connection in this respect between chorea, hysteria, and the delirium of drunkards." Again—"In chorea that part of the nervous system which ministers to voluntary motion is chiefly affected; whilst in hysteria the nerves on which organic life and involuntary matters depend are principally irritated; and in the delirium which takes place in drunkards those portions of the brain which are particularly associated with the manifestations of thought and reason are labouring under disease." Thompson speaks of "choreic movements being mistaken for drunkenness." It is interesting to find that Youatt speaks of chorea in the dog as terminating in epilepsy, or palsy, or paralysis-agitans. Todd closely associated chorea with certain epileptic phenomena, for he was of opinion that the actual state of the nerves and nervous centres, upon which choreic hemiplegia depends, was very analogous to that which exists in the so-termed epileptic hemiplegia.

As regards the SECONDARY AFFECTIONS which supervened in the fatal cases, we have two instances (viz., 5 and 8) in which so-termed *phlegmonous* or *erysipelatous* inflammation existed. In one of these there was empyema also.

With reference to the oft-mooted question as to what links may be supposed to exist in the chain of causation of that perversion or disorder of the muscles secondarily and of the nerves primarily,[1] which results in the condition termed chorea, it may be worth while to consider how much light and instruction these fatal cases tend to afford. The histories of many of them show that some disturbance of the generative system existed, for in five cases (Nos. 3, 5, 7, 12, and 13) the catamenia were defective, and in two cases (1 and 15) pregnancy existed.[2] Now, it is well known that irritation of the genito-urinary system has been often looked upon as an exciting cause of the malady. Out of the six cases which Dr. Bright had known to end unfavorably, in one "the most unequivocal evidence of extreme uterine irritation was found after death;" in a second one (at the Manchester Infirmary) the patient was four months advanced in pregnancy; and in two others the patients were of an age "when

[1] Not of the MOTOR nerves alone, of course, as it is well known that the sensory nerves are oft-times also affected, as proved by the anæsthesia and sometimes hyper-æsthesia which exists.

[2] Later on I shall be able to quote one or two cases of non-fatal chorea, in which pregnancy existed, one being that of a woman lately under Dr. Page's care at the hospital.

uterine irritation is most likely to exist." Bright assumed that it was probable that the uterus was in many cases "the source of that general irritation which so strongly marks chorea, inasmuch as many cases were connected with irregularities in the menstrual discharge, or with amennorhœa."

Romberg says that "the occurrence of chorea before the first supervention of the catamenia, or during amenorrhœa, or even during pregnancy, proves that the uterine system may be the source of the irritation;" and quotes three cases of the kind which came under his own notice, in all of which pregnancy existed. In one case the woman became pregnant a second time, and again had chorea. He observes that "the chorea generally commences at about the third or fourth month of pregnancy; it rarely occurs earlier, and then less frequently during the latter months." He quotes cases bearing on the question from Dr. Lever's paper "On Disorder of the Nervous System associated with Pregnancy and Parturition."[1] He remarks that it is quite exceptional to find chorea occurring after delivery, whether at the full period or premature. I find, however, a case recorded by Spiegelberg in which chorea came on in the latter half of pregnancy.[2] Dr. Levick, of America, in 1862, recorded three cases of chorea associated with pregnancy, and described uterine irritation as one of the causes of the disease. Quite recently Gubler and Dumont have recorded a very severe case of chorea in a woman five months pregnant, who was cured in eight days by large doses of bromide of potassium.[3]

Trousseau, speaking of pregnancy in connection with chorea, states that the disease is owing merely to the chlorosis which so frequently attends pregnancy.

Again, as regards MENTAL EMOTION OR ALARM being influential in exciting or determining the choreic state, it will be seen that out of the sixteen cases there are eight in which fright or other emotion was supposed to have contributed to its production (viz. Cases 1, 5, 8, 9, 10, 12, 13, and 15); in others, it was either denied or not ascertained to have occurred. Some observers are inclined to protest against the idea that fright is nearly so adequate a cause of the affection as is generally imagined, but there can be no doubt of this being frequently the case, and almost every author who writes on the subject supports the supposition by authentic cases. One of the most positive and remarkable cases of this kind is quoted by Dr. Bright. It was that of a child, aged 9, who, having got well of an attack of chorea, was sleeping with his father. The father had an attack of apoplexy, which so frightened the child that "FROM THAT TIME the chorea returned." Mayo, in his 'Outlines of Human Physiology,' p. 170, relates the case of a woman who,

[1] 'Guy's Hospital Reports,' second series, vol. v and vol. vi.
[2] Quoted in the 'Sydenham Society's Year-Book,' 1859, p. 389.
[3] See 'Bulletin de Thérap.,' 1865-8, p. 178.

during pregnancy, was greatly frightened; the alarm induced chorea in the fœtus. The child grew up, but always remained choreic.

As respects the history of RHEUMATISM or rheumatic symptoms having existed, we have mention of it doubtfully in Cases 3 and 10, but decidedly in Cases 4, 6, 11, and 12; in the last instance, the rheumatic symptoms came on during the absence of the catamenia.[1] Presumably also, in Cases 1, 9, 14, and 15, rheumatism may have existed, as after death it was found (to be noticed hereafter) that cardiac affection existed. In Case 16 particular inquiry was made, and a complete denial of any previous rheumatism given, although the heart was obviously recognised as being diseased during life, and found to be so after death. At the present day we in England almost unanimously connect chorea and rheumatism together (whatever may be the mode of connection); this, no doubt, is mainly owing to the researches of Bright and Todd, following those of Bouillaud; still, there are those who have only found them to be at times coincident, and observers are much divided on the subject. I shall speak of this again when reviewing my series of non-fatal cases. In the mean time I may state that Romberg, a high authority on all nervous diseases, says that the rheumatic disposition was rarely traceable in the cases which he has observed. He, however, noted cases of chorea as being greatly affected by climate and weather, being always worse in winter; and mentions that the disease occurs more frequently in the southern than the northern climates. Peacock found that in 14 cases of chorea rheumatic or cardiac symptoms had existed in 5, but states that this proportion is probably too large. Trousseau says, that of all predisposing pathological states, rheumatism is the most marked and the least questionable: and one of the most recent French writers looks upon chorea as a manifestation in the rheumatic diathesis.

As regards the PATHOLOGICAL ANATOMY presented by the various fatal cases, we find that congestion (more or less complete) of the nervous centres (brain or spinal cord, or both), was met with in six cases (viz. 3, 4, 10, 12, 14, and 15), whilst in Case 7 there was actual softening of the spinal cord, and in Case 14 the spinal cord was otherwise affected. In Case 15 there was softening of certain parts of the brain.[2]

In Cases 2, 3, 4, 10, and 13, there were proofs of congestion and

[1] It is interesting to find that Dr. Todd established a connection betwen rheumatic fever and deranged *uterine* secretion. He stated that some of the most severe cases of rheumatic fever he had ever seen followed dysmenorrhœa. He observes, "It would seem as if, in these cases, the uterus were but imperfectly evacuated, and its contents becoming decomposed and getting into the circulation, produced a morbid state of the blood, which gives rise to the symptoms under which the patient labours, and requires for its cure the elimination of the unhealthy material by the various emunctories—a state similar and analogous to pyæmia."

[2] With reference to such lesions in connection with chorea and chorea-like symptoms, it will be not uninteresting briefly to quote such cases as have been pre-

other graver lesions of the genital system; in Cases 1 and 16 (as before noticed) pregnancy existed. In Case 2 the peritoneum was greatly congested, and in Cases 2 and 3 the condition of the intestines was remarkable, inasmuch as they contained fæcal matter which was in a peculiar and exceptional manner adherent to the walls of the bowel.

Coming now to the state of the HEART, it was found that out of these sixteen cases IN NO LESS THAN TEN CASES there existed more or less fibrinous deposit or granulations upon some portion of the heart's valves or lining membrane, viz. in all Cases excepting 2, 5, 7, 8, and 13; in Case 6 old pericarditis existed, and in Case 10 we have decided evidence of recent pericarditis having existed, although in this case we have no mention of a cardiac 'to-and-fro' murmur having been ob-

sented to our London Pathological Society. Thus, at page 16 of vol. v is a case of chorea following a fit, related by Dr. Hale, in which chronic disease of the cerebral dura mater was found. In a second case, which came on immediately after a fright, related by Dr. Goodfellow (see vol. xiii, p. 19), extensive softening of the brain and spinal cord was met with. In a third case, related by Dr. Broadbent, at p. 246 of the same volume, a tumour was found arising from the centre of the spinal cord.

Romberg quotes seven fatal cases in which similar organic lesions were met with after death. They are as follows:—Case 1 was quoted from Dr. Hughes' digest of 100 cases of chorea (see 'Guy's Hospital Reports,' 1846). Here the fornix and the surface of the third cerebral ventricle were softened. An OPAQUE GRANULAR DEPOSIT also existed on one of the SEMILUNAR VALVES of the heart. Case 2 was that of Dr. Bright's, already quoted. Case 3 was related by Frerichs. In this case the choreic movements existed DURING SLEEP.[1] After death the medulla oblongata was found pressed upon by an enlarged odontoïd process. Case 4 was from Cruveilhier, and was combined with paralysis. Softening of the occipital cerebral convolutions and atrophy and degeneration of the spinal cord were found. The remaining cases were from Romberg's own practice. In one case, aged 76, chorea had existed since she was six years old. Softening of the crura-cerebri and atrophy of the brain were met with. In Case 6 the central parts of the brain and corpora quadrigemina, and in Case 7 softening of the spinal cord, were found. Dr. Peacock (see number of this Review for Oct., 1863) records the fatal case of a boy, aged 11, who died in a comatose state six days after admission into the hospital with chorea, which had been observed one month. After death the arachnoïd membrane, on the surface of the hemispheres, was found opaque, and much serum existed beneath it and in the ventricles. The spinal cord was not examined. The pericardium and heart were healthy, except that two of the aortic valve flaps were congenitally united. Recently Mr. Hine has recorded, in the 'Medical Times and Gazette,' August 5, 1865, the case of a pregnant woman who had chorea, apparently caused by emotion, in whom softening of the spinal cord was found. Dr. Aitken, in a case of chorea, found ('Glasgow Med. Journal,' vol. i.) that the sp. gr. of the corpus striatum and optic thalamus was decidedly greater on one side than on the other. Dr. Chambers, in his 'Lectures,' pp. 361 and 362, mentions that in three fatal cases of chorea he found after death that the nervous system was perfectly healthy. In a fourth fatal case tubercles were found in the spinal cord. Skoda, speaking of softening of the septum lucidum and fornix, sometimes found in fatal cases of chorea, suggests that an EXUDATION in the spinal cord or in the brain is the immediate cause of the disease ('Canstatt's Jahrb.,' vol. iii, p. 57). I propose to examine the records of all fatal choreic cases which I can find, to ascertain in what proportion organic lesions existed.

[1] Marshall Hall observed that sometimes the movements continued during sleep if dreaming existed; and Youatt noticed that in the dog if the sleep was disturbed choreic movements might continue.

served during life.[1] It is noticeable that in several of these cases in which after death fibrinous deposit on the heart's valves existed, we have no record of the occurrence of any valvular murmur whatever during life. It is worthy of comment that in several of those cases in which, after death, fibrinous deposits on the heart's valves, &c., were discovered, we have no record of the existence of any valvular murmurs whatever before death; indeed, only in Cases 9, 15, and 16, does such a record exist. In Case 5 we have a distinct notice of a double valvular bruit at the base of the heart having existed and having subsequently disappeared;[2] in this case we have no mention of any fibrinous deposit on, or other affection of, the heart's valves. In Case 16 the pericardium was found to be distended with serum, and possibly this caused the patient's death. This sequel in cases of chorea is, of course, of uncommon occurrence. It is, however, mentioned by Dr. T. Thompson, in his article above quoted, that in chorea serous effusions into the arachnoïd cavity and into the PERICARDIUM may come on.

Concerning the presence of the fibrinous granulations or fringes so often met with in the heart's valves in these cases, the readers of the case of maniacal chorea described by Dr. Tuckwell in this Review (to which I have alluded at page 208) will remember that that gentleman drew marked and renewed attention to the probable existence of this phenomenon in the majority of cases of fatal chorea; also to the fact that softening of the brain or spinal cord frequently was found in such cases, and will remember that he supposed that the softening of the nerve centres often resulted from the plugging up of the cerebral and spinal arteries, and accounted—as would irritation of the same parts from a similar cause—for the chorea. Dr. Kirkes had, in 1863, pointed out that when chorea and acute rheumatism are associated the connection really was between chorea and valvular disease of the heart; and Dr. Tuckwell shows that Dr. Kirkes had been the first to indicate that chorea "was the result of irritation produced in the nerve centres by fine molecular particles of fibrine which are set free from an inflamed endocardium, and washed by the blood-current into the capillaries of those centres." Dr. Kirkes, with

[1] I lately had a most interesting instance of the rapid way in which pericardial friction sounds may come on. The patient was brought into the hospital for rheumatic fever, and was examined very closely. The heart's action was increased, but, though carefully listened for, no bruit (exo- or endo-cardial) could be detected. In two hours afterwards a positive and distinct friction sound was heard all over the base of the heart. That this suddenly occurring pericarditis may be swiftly fatal also is shown by a case of chorea, related by Dr. T. K. Chambers in his 'Lectures,' p. 173, in which loud friction sound came on in the course of the day, and the patient died of pericarditis in the evening.

[2] Such disappearance of cardial murmurs in chorea might take place if the bruit was resulting from that condition called anæmic, or from some irregularity (of choreic origin) of muscular or tendinous fibres controlling the movements of the heart's valves or the exit of the apertures of valves, or even, in some cases, where owing to recent fibrinous deposits connected with them, such bodies are liable to be washed off by the blood stream.

other observers, had noticed the occurrence of softening of the nerve centres in this affection, but erroneously thought that all such were cases of pale or white softening, and did not attribute it to embolism of large vessels, as does Tuckwell, but rather to "the imperfect nutrition of the nervous centres, or the unhealthy state of blood which affords the development of the chorea."

It will be seen, on reading Dr. Kirkes' paper, that he does not, in forming this view, repudiate the influence assigned to supposed exciting or outward causes; for he remarks that, owing to this assumed defective nutrition of nerve centres, they become unnaturally capable of being affected and excited by what would, in a state of health, prove to be but ordinary impressions; and with this tendency they are liable additionally to be affected by blood rendered irritating by rheumatic affections or by disease of the heart's valves. With the above views of Kirkes and Tuckwell in mind, the large proportion of cases which I have recorded, in which the heart's valves are affected, will prove, I think, of considerable interest. Still, for my own part, I am not at present prepared to give adhesion to a necessary connection between even the grave and fatal cases of chorea and embolism, whether the embolism consist in plugging up of large, tangible vessels, or in the circulation of minute atoms of fibrine within the minute capillaries of the nervous structures giving rise to "IRRITATION;" although, on the whole, I incline to think the latter supposition is, perhaps, the more tenable.

I venture to throw out some considerations, as a contribution to the question, to which I have been led by thinking over the subject.

In the first place, either view necessitates the division of all true choreic cases, not merely into those that are and those that are not fatal, but into those that depend upon embolism and those which do not; although in each kind of case the phenomena be not only so alike, but so identical, that until death it would be impossible to predicate of any one instance to which category it pertained.

Dr. Todd had suggested that the choreic cases of adult life, and more advanced ages, might not be due to the same morbid condition "as that which gives rise to the ordinary choreic convulsions of early life." Dr. Tuckwell suggests that, possibly, the causation of the chorea in fatal cases may be different from that of the non-fatal ones; that, in fact, there may be a centric and an excentric chorea; but I think he seems inclined to suppose, though he leaves it an open question,[1] that in all kinds of chorea we have the de-

[1] He says, "We have not as yet sufficient evidence to justify the conclusion that embolism is a direct cause of severe chorea, but we have enough to warrant the strong suspicion that such may be the case, and to fix the attention of medical men on the heart and blood-vessels in the future examination of all fatal cases." Dr. Tuckwell will, I hope, excuse my quoting from a letter which he wrote to me some months ago on the subject. He observed:

"I was glad to find in the post-mortem you made in your fatal case of chorea [the case referred to at foot-note of page 220] that the mitral valve was studded with beads of soft fibrine. I have a notion that, if the valves of the heart are

position of fibrine on the heart and valves, which, being removed and transported, produces the cerebral or spinal embolism which is the cause of the affection. Certainly, as both he and Kirkes suggested,[1] inquiry led to the finding of this deposit in a very large per-centage of fatal cases, and very careful inquiry, instituted WITH THE OBJECT OF FINDING SUCH, may lead to their discovery in a still larger proportion. Still, even if they were met with in ALL cases, something more, I would with deference submit, would be required to warrant the inference being inevitable that the essential cause of chorea was embolism; and for the following reasons:—Supposing that chorea were owing to the presence of MOLECULAR fibrinous material in the blood, circulating in all directions and parts, as fibrine would do in this form of mechanical subdivision, I would ask how we could find an explanation of the fact that chorea (under conditions operating so generally) is so frequently unsymmetrical and one-sided as it is, or even confined, it may be, to certain muscles or series of muscles. Should we not of necessity get other and graver motor symptoms than merely defective harmony of associated movements? I suppose that the "ONE-SIDED" or mere local effect from such a MECHANICAL cause would be considered as being not at all analogous to those similarly partial effects produced by certain chemical alterations of the blood (such as we have often in cases of uræmia, in rheumatic, neuralgic, miasmatic, and other blood-poisons strictly so called), in which the supposed materies morbi has what may be termed an affinity for certain parts or tissues, or in which, so to say, such tissues appear to ATTRACT the baneful elements.

Again, when by experiment fibrine, in a minutely divided state, or any other finely powdered substance, is made to circulate in the blood-current, do we meet with results at all comparable with the symptoms

carefully examined in all fatal cases of chorea, similar, though sometimes very delicate, beads will be found. If you should open a body in which this appearance is not present, will you kindly tell me? I am sure that the appearance is sometimes overlooked in these cases in the eagerness of the pathologist to find something in the spinal cord. I think I told you of a case I saw in the Hôtel Dieu, where the heart was opened as usual, and put aside as *healthy*; and when the spinal cord was sent to Robin for examination to supply Trousseau with material for a clinical lecture, a German student, who was present and poking about among the *débris* as only Germans who wear spectacles can poke, routed out the heart, and found that, when examined minutely, the mitral valve was fringed on both flaps with very fine and delicate beads of fibrine. This was shown to Trousseau, but he took no notice of it, dilating on a supposed enlargement of the capillaries of the spinal cord which had been found. Again, a woman in the fourth month of pregnancy died with bad chorea in the Vienna Hospital, and was brought down to Rokitansky. His assistant, who made the post-mortem, dilated on the pregnancy as the cause of chorea, and took no notice of the condition of the cusps of the aortic valve, which were *covered with abundant, very delicate, beads of fibrine.*" These are obviously the two cases which he quotes in his paper to which I allude.

[1] Kirkes had prophesied, as quoted by Tuckwell, "that future experience will still more positively demonstrate that an affection of the left valves of the heart, with the presence of granular vegetations upon them, is an almost invariable attendant upon chorea, *under whatever circumstances the chorea may be developed.*" The italics are my own.

of chorea? If, also, the chorea were the result of cerebral or spinal capillary embolism, surely we ought always, in fatal cases, even when such ulterior stages as suppuration and abscess are not arrived at, to encounter lesions (stasis, congestion, or other appearances met with in that condition which goes by the name of *secondary* deposit, the result of mechanical impediment) which, if they existed in such delicate tissues as those of brain or medulla, would be at once apparent. Then, if they existed at all, they would most likely, according to some, be in the neighbourhood of those parts which Dr. Todd pointed out as probably constituting the centre of volition and the centre of emotion. Where we have reason in other cases to suspect capillary embolism, have we not rather the symptoms, and also the post-mortem appearances, of pyæmia or of gangrene? I cannot call to mind a single instance of acknowledged capillary embolism attended by phenomena which could even suggest chorea. Then, again, supposing chorea to be caused by plugging of the larger cerebral or spinal vessels, how rarely in those cases in which such a state is determined to have existed, producing softening, did chorea-like symptoms arise; and how rarely have such symptoms been mentioned in cases of softening of nervous structures of any description or arising from any cause[1] (though, of course, convulsive action may have existed). How rarely, again, do choreic symptoms accompany rheumatism, a condition in which fibrinous deposits on the heart's valves so often exist. Moreover, under such a supposition as the above, how should we be able to account for that sudden occurrence of the disease as a result of mental emotion, which undoubtedly often exists, or, what is perhaps more to the purpose, for its frequently sudden disappearance or cessation,[2] or for the good effects at times found to attend the use of certain remedial measures? Will it ever happen, I would ask, that watching the effects of remedies of whose action physiologically we may know or learn something will give a clue as to the part of the cerebro-spinal axis affected in chorea, if, indeed, any one part is specially concerned in this affection? The chorea ought (under the above supposition), taking an average of cases, to be found mainly affecting one side in correspondence with the frequency with which embolism occurs on one side. Perhaps investigation may prove this to be so.

Again, it might be asked, if there was merely a mechanical cause

[1] Dr. Tuckwell quotes from Dr. Todd to show that cases of softening of the brain are sometimes attended by movements so choreic as to be mistaken for real chorea.

[2] Many cases might be quoted illustrating the rapid removal of the affection. A remarkable instance is mentioned by Skoda of severe and general chorea being cured in *five* days by tartar emetic and cold douches to the head. Dr. Guy, of King's College, observes:—"One of the worst cases of chorea which I have seen, and which combined constant restlessness and grotesque action of the muscles with mental incoherence, was cured within *ten* days by aperient medicines only." A very severe case of a form of chorea, of which I have notes—that of a young man in Derbyshire—took its leave during the time the patient was being carried to an infirmary.

(which, of course, would be constant in operation), such as embolism, why should the movements be so decidedly and universally *uninterrupted* during quiet sleep? Or why should certain peculiarities as to age or sex be considered as predisposing influences?

Recognising the frequent existence of these fibrinous deposits or granulations on the heart's valves in chorea, I should be much inclined to look upon these post-mortem appearances rather as results of some antecedent general condition of the blood, common also to the choreic condition. It is very freely recognised that this affection is frequently, in some way or other, connected with that condition of blood which obtains in what we call anæmia,[1] or that existing in rheumatic constitutions. In both of these states, we know that the fibrine of the blood is much in excess[2] (as also it is in pregnancy, another condition looked upon as obnoxious to chorea), and in these states we know that the fibrine (with which the blood is surcharged) is very prone to be readily precipitated, either owing to its superabundance or from other obscure and acquired properties (possibly also from some interference with the relation of the fibrine and the other constituents of the blood) upon the heart's walls or valves.[3] May not this hyperinosis be the explanation of the coincidence alluded to? In most cases the deposit is probably very slight, and in many cases so slight as to require search for it. May it not infrequently be that it is often only formed in quite the dying state? Speculation might suggest that the fibrinous deposits arise from some interference with the degree of solubility of the fibrine, induced by the presence of some unwonted elements within the blood (some result of tissue metamorphosis), produced by the excessive muscular action and other functional disturbance which exists in the choreic state, thus being not in any way related to this state as a cause, but as a consequence.

Postcript.—For the following notes of a highly interesting case of chorea, successfully treated by the oil of male fern, I am indebted to my friend, Dr. Giles, of Deptford. It illustrates well quick recovery under the use of remedies.

"*Case of acute chorea, caused by the presence of a tapeworm, and successfully treated by the oil of male fern.*

"I was requested to see the following patient by one of the surgeons of the Pimlico Dispensary, during his absence in the country. He described it to me as a complication of rheumatism, chorea, and worms, and said that the only remedy that seemed to do any good was atropine, which he had given in gradually increasing doses. She had been under his care for about a month.

[1] Some authorities look upon rheumatism as causing anæmia.

[2] Andral, giving 3 as the average relative proportion of fibrine to 1000 parts of healthy blood, states that the variation in disease ranges from 1 up to 10½ per 1000. In cases of anæmia he gives the proportion of fibrine as 3·5, and in rheumatism as 10 per 1000.

[3] I do not speak of the condition of the heart's valves alluded to as being the result of endocarditis.

"Ellen L—, æt. 9, residing in Pimlico, was first seen by me on 29th September, 1863. She was evidently suffering from acute chorea; had had no sleep for four days and nights; there was constant irregular spasmodic action of the whole body and face; she was never still for a moment (continually working). A bed-sore had formed over the sacrum the size of the palm of the hands, and the elbows were much chafed. She from time to time uttered a feeble whine, and wore a pitiable look of distress; her consciousness was perfect. The tongue was dry and brown, and sordes had accumulated on the lips. The pulse was exceedingly rapid and feeble. The pupils were moderately dilated. She had taken no nourishment, except a little wine and beef-tea, for some days. She seemed rapidly sinking. The mother told me she had been in the habit of passing portions of tapeworm for the last three months, and that large pieces had come away while under treatment; she had never seen the head. I saw by the patient's letter that scammony and calomel had been the medicine used. Thinking all these nervous symptoms might proceed from the intestinal irritation, I resolved to try a full dose of male fern. The mother was at first unwilling to have any change made in the medicine (morphia) which had last been prescribed, thinking the case hopeless, but at length yielded. I prescribed Ol. Filicis Maris 3j, ex Mistura Acaciæ 3iss, to be taken immediately, and to be followed in six hours by Ol. Ricini 3ss.

"On visiting her the following morning, I found the child asleep, quite free from any convulsive movement. The mother told me the draught had acted freely four hours after taking, that the child turned very pale and faint, and she thought she was dying. She however gave her some wine, which revived her, and in the course of a few minutes she was fast asleep and quite quiet, with the exception of occasional twitching. She slept for two hours; on waking she took some beef tea, and then slept again. When she awoke the convulsive movements commenced again, though in a greatly mitigated degree. About seven yards of tapeworm were collected, and the head with the four suctorial discs found. The castor oil had not been given.

"The subsequent history is simple. She continued to improve daily, the mouth and lips cleaning. The bed-sore gradually healed under the use of nitric acid lotion. In a few days all convulsive movements had ceased, and in ten days she was able to leave her bed. The medicine prescribed was bark and ammonia, generous diet, and a little wine at first. On the 16th of September I took my leave of her, she having been able on the previous day to leave the house. During her convalescence I examined her heart several times, and always found a distinct mitral murmur.

"I have lately seen her mother, and she tells me her daughter has enjoyed good health ever since, and has seen no more tapeworms."

It may be remembered that in describing the post-mortem examination in the fatal case, No. 16, I said that the spinal cord was placed in a solution of chromic acid for future examination. Mr. Lockhart Clarke has since then kindly examined it for me, and found that, extending nearly half an inch downwards from the second cervical nerve, an oval area of considerable granular disintegration, having at its outer side another strip of the same disintegration, existed at the base of the "caput cornu" of the grey matter.

Having concluded the details of the fatal cases of chorea which I have to record, and offered such observations as were suggested by them, I will now give some particulars regarding eighty non-fatal cases, all of which, with two exceptions, occurred in my former out-patient practice at the hospital.[1] To these I shall add the relation of a few cases illustrating one or two of the more unusual or complicated forms of chorea. The eighty cases I have arranged as follows in a tabular form, which will enable them to be compared with each other with some degree of facility.

[1] For help in accumulating the details of many of these cases I have to thank many of our hospital students, who so willingly from time to time assisted me in collecting notes of interesting cases in the out-patient department.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable o assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
1	M.	12½	Right.	Two weeks.	None known, but had ascarides nine months previously.	Had an attack four years previously, owing to fright.	Remarkable; rolling about of the tongue.	Calomel and jalap at intervals. Quinine and steel, and afterwards spirit of chloroform added.	Five weeks. Became quieter, then left off attendance.	No worms seen.
2	F.	12	Left.	...	None known; no fright, but had ascarides one yr. previously, and four years ago had a fall on the head.	Had similar attack, and was in-patient previously for it, and then the whole body affected.	Right pupil rather larger than the other.	Steel wine and aloetic wine together.	Two weeks.	
3	M.	11	Left.	...	...	No.	...	Jalap and calomel, followed by steel wine.	One week.	
4	M.	11	Left. Confined to the face and neck.	Attack has been gradually coming on for four years.	None assignable. No worms, no fright, no rheumatic fever.	No.	...	Jalap and calomel, followed by syrup of iodide of iron, and later on by cod-liver oil.	Was patient five weeks. Discharged as well.	

5	F.	8½	Right.	...	Now has ascarides; no other cause known.	Had similar attack four mths. previously on LEFT side, and got quite well.	...	Steel wine, scammony, and calomel; followed by cod-liver oil and steel.	Was patient for eleven weeks, and quicky improved. Discharged as well.	
6	F.	14	Right.	Three or four mnths. Been in-patient.	Had ascarides of late; no other known cause.	No.	...	Jalap and calomel, followed by syrup of iodide of iron, quinine, and steel, and shower baths.	Fifteen weeks.	Been beaten much for dirty habits and bad behaviour. Pulse always feeble; no worms seen. Much relieved.
7	M.	5½	Right.	For six months had loss of power in the same side, and been in-patient.	Has ascarides; no other cause known.	Had one previous attack, thought to be owing to sudden removal of disease of the eyes, which lasted seven weeks, and got quite well.	...	Steel wine, jalap and decoction of aloes.	Fifteen weeks. Dismissed much improved.	Had dropsy after scarlet fever two years previously.
8	M.	17	Both sides. Head and neck but seldom.	Two years.	Had rheumatic fever five weeks before present attack began. No other assigned cause.	...		Syrup of iodide of iron. Shower baths.	Two weeks. Dismissed "all but well."	Florid countenance.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
9	F.	11	Both sides.	Nine months.	Had rheumatic fever five weeks before present attack began. No other assigned cause.	Had two previous attacks, and was in-patient (both sides being affected on each occasion). Was well of first attack in nine weeks; of the second attack in six or seven weeks.	Had been out of health for a year since he broke his leg. In previous attacks speech greatly affected, and teeth "apt to clench on the tongue."	Under jalap and calomel, followed by zinc and strychnia, he greatly improved; later on he had steel, and afterwards, as headache came on, salines and mercurial aperients, then belladonna plaster to cardiac region, with antimony.	Twenty-six weeks. Result doubtful, as he ceased to attend.	The mother had had chorea three times. Often had pain in the head, and was noticed as being dull and nervous at times; at first pains in the knees, and then swelling of the back of the hands, and strong cardiac action, with a systolic bruit, supervened.
10	M.	12	Left.	...	Ditto.	Had similar attack twice previously, and been in-patient both times.	Much flatulence, generally wakes up in morning with pain in the head and sickness, when he becomes "white, and shaking, and cold."	Syrup of iodide of iron and quassia, rhubarb and magnesia aperients.	Only a patient one week, and discharged as being well.	
11	F.	18	Right.	One month.	Ditto.	No previous attack.	Eyes rather staring, speech affected.	Mist. ferri comp. and dec. aloes comp.; senna, calomel, and hyoscyamus aperients.	Attended but one week. Result unknown.	Had only been married six weeks; a sister had similar attack six years previously.
12	F.	14	Right.	...	Ditto.	None.	Speech affected.	Sulphate of zinc, steel, and aloes wine.	Attended but one week. Result unknown.	
13	F.	10½	Left chiefly, but not entirely.	...	Ditto.	None.	...	...	Attended two weeks. Result unknown.	
14	F.	24	Right.	Three weeks.	Ditto.	Had previous attack twelve years previously from fright.	Often bites the tongue, troublesome only when eating. Bronchitic symptoms.	Treated only for bronchitis.		
15	F.	11	Right.	Twelve days.	Ditto.	None.	For two months had lost much flesh; formerly was very deaf, but less so since attack.	Calomel and jalap.	Six weeks. Result unknown.	
16	F.	13	Both sides, but chiefly the left.	...	...	Previous attack four years ago.	During sleep much affected.	Sulphate of zinc and steel, calomel and blue pill purges, ice to the spine, opium plaster to cardiac region.	...	Had much headache in illness.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
17	F.	11	Both sides, but chiefly the right.	Five or six weeks.	...	Had several attacks since 3½ years old, and generally in autumn, remaining until past Christmas. First attack followed measles.	Has some choreic movements during sleep; often has headache, and then "has something before his eyes."	Calomel and jalap, quinine and iron, and zinc; followed by shower baths and decoction of aloes.	Six weeks. Result unknown.	
18[1]	F.	14½	Right.	Three weeks.	Has large number of ascarides; attack followed an attack of palpitation of three weeks' standing. No cardiac bruit found at any time.	Had an attack three years previously from a fright, and then the same (the right) side chiefly affected.	Often has pains in limbs, but never rheumatic fever. Often had palpitation.	Calomel and jalap, quinine and iron, and zinc; subsequently one third of gr. of extract of belladonna every night; shower baths.	Four or five months.	There was some dragging of the affected foot, and a slight leaning forwards, as if from tendency to fall; great weakness of the back; appetite ravenous; said to be better after the belladonna pills. Catamenia irregular.

[1] One year afterwards this patient again had chorea, and was out-patient for eleven weeks, and got quite well under the use of carbonate of iron and shower baths and the Mist. Ferri. comp.

19	F.	10	Limbs on both sides.	Two months.	None assignable.	...	Previous to illness had much pain in head. Symptoms first affected the mouth and tongue. Mouth became drawn to the right, and speech less distinct. Feet became more affected, and hands less so.	Shower baths. Sulphate of zinc, quinine and steel, calomel and jalap; zinc increased to seven grains twice a day.	Fourteen weeks. Dismissed as well, excepting being "rather fidgety."	No sickness produced by the large doses of sulphate of zinc.
20	F.	11	The entire body.	Three months. Been in-patient five weeks.	Fright. Had had ascarides for one year.	Previous attack, several months before.	The right pupil became larger than the left. Had nausea, but no vomiting.	Quinine and zinc, calomel and jalap, calabar bean.	Two months. Discharged much improved.	Improved much after began to take the calabar bean.
21	M.	15	Left.	Five weeks.	No cause assignable.	Had an attack two years previously, and was in-patient for eleven weeks.	Slight loss of power in the left side.	Zinc and valerian, calomel and jalap.	Ten weeks. Left off attendance, and result unknown.	
22	F.	6	Entire body.	One week.	Ditto. Had fallen down stairs three weeks previously.	...	...	Quinine and iron, scammony and calomel.	Two months. Dismissed very much improved.	Her mother had chorea when aged 14.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
23	F.	10	Left.	Two months. Been in-patient one month.	No cause ascertainable. But had had rheumatic fever three months previously. Heart natural.	...	Had had pain at the left side, before she came to hospital. Appetite voracious; lost flesh since illness began.	Quinine and iron, calomel and jalap.	Three months. Discharged as very much improved.	
24	F.	10	Entire body.	Four days.	Fright and quarrel. Had had rheumatic fever three months previously. Heart natural.	None.	Always worse in bed, when first roused up from sleep.	Calomel and jalap, steel wine.	One week. Result unknown.	
25	F.	20	...	Had symptoms for eighteen years, off and on.	Fright, when aged two years.	...	Subject to pains of so-called "rheumatic" kind." Choreic spasms confined to muscles of face and eyelids.	Senna aperients, colchicum and opium, iodide of potash and valerian.	Three weeks. Rheumatic pains recovered from, choreic spasm the same.	
26	F.	14	...	...	Fright.	Previous attack, and in-patient four years previously.	Has symptoms indicative of phthisis.	Quinine and iron, squills.		

27	F.	11	Right.	Three months.	Followed immediately an attack of rheumatic fever. No cardiac bruit existing.	None.	...	Steel wine ammonio-citrate of iron, followed by sulphate of zinc.	Eleven weeks. Discharged the same.	
28	M.	11	Right.	...	No cause assignable.	...	Often falls when walking.	Steel calomel, and jalap, quinine and iron, and zinc subsequently.	Two months. Discharged himself, and result unknown.	
29	F.	18		Three weeks.	Had had rheumatic fever, and six weeks in bed nine months previously. Cardiac sounds natural.	None.	Face and eyes not affected. The hands first affected by spasms, & then the legs and the left of face only three days before attendance.	Steel and quinine, rhubarb aperients.	One week. Result unknown.	Catamenia only appeared once since rheumatic fever. Says that she sees stars when moving about, and at times has double sight. Occasionally great palpitation.
30	F	21	Right.	...	Had had several miscarriages of recent date. No other cause ascertainable.	An attack four years before, affecting the right side.	Sensibility of the skin generally much impaired.	Zinc and steel and valerian.	Two weeks. Result unknown.	
31	F.	15	Entire body.	...	...	An attack one year previously.	Pyrosis.	Calomel and rhubarb and bismuth.	One week. Result unknown.	

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
32	F.	14	Left.	Five weeks.	...	...	Occasional headache, at times vomiting.	...	Two weeks. Result unknown.	Catamenia never appeared.
33	M.	8	...	...	None.	No actual attack, but one year previously for about three months was in habit of twisting about the shoulders very much.	Choreic movements very peculiar, consisting chiefly in opening the mouth about every minute. *This goes on in sleep, but less frequently.*	Syrup of iodide of iron.	Seven weeks. Much improved.	Before the attacks has much shrugging of the shoulders, and at times headache.
34	M.	15	Left.	...		An attack three years previously, and then the *mind was affected.*	...	Shower baths. Mist. ferri co. and dec. aloes. Zinc subsequently.	Two months. Improved, but result unknown.	Father died of apoplexy.
35	M.	16	Right.	Two weeks.	Ditto.	An attack, lasting four months, seven years previously. Galvanism used without benefit. Both sides affected. Lost speech.	The urine was apt to be retained, and sometimes for twenty-four hours. Pupils very dilated.	Aperients, zinc and sesquioxide of iron.	Was two weeks under treatment. Then left, and again returned two months afterwards. Became so well that he was discharged with a fortnight's medicine.	Had peculiar dislike to anything round the neck.

36	F.	14	Both sides, but chiefly the left.	...	None.	An attack four years previously.	Pupils unusually dilated. Is said to "plunge" when asleep in bed.	Salt-water shower baths. Quinine and zinc, and steel subsequently; also cod-liver oil.	One month. Relieved.	
37	F.	9	Left.	...	Began during recovery from rheumatic fever and cardiac affection.	None.	Chiefly arm and hand affected.	Steel wine. Shower bath.	Three weeks. Left off attendance. Improved.	
38	F.	8	Left.	One week.	...	...	...	Valerian, belladonna, steel.	One week. Result unknown.	
39	F.	8	Right.	Eight days.	Fright. Has ascarides.	...	Subject to screaming at night.	Zinc, steel, and quinine, calomel and jalap; shower baths.	Two months. Quite recovered.	
40	F.	7	Right.	Six weeks.	Had sores on head three months before. No other cause known.	...	Headache, and pain from bad teeth. Liable to choke at times when eating.	Zinc and steel. Blistering the neck.	One week. Result unknown.	
41	F.	10	Entire body.	...	None known.	...	Restless when asleep. Liable to pains in the joints.	Calomel and scammony, zinc increased to 7-grain doses, extract of belladonna.	One month. Became worse and made inpatient.	

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
42	F.	6½	Right.	...	...	An attack three months previously.	...	Calomel and scammony, quinine and steel.	One week. Became much quieter.	
43	F.	12	Whole of right side; and the left side of the neck.	...	Fright, which appeared to bring on general convulsions, after which the choreic spasm set in. Has ascarides.	...	Had much loss of power of left side; much pain in the groins came on, causing screaming. In sleep the eyes would twitch much.	Senna and valerian, arsenic, steel; other aperients.	...	A sister, now aged 8, is beginning to imitate the patient "blinking and acting," as the mother said.
44	F.	17	...	Two weeks.	...	...	Liable to hysterical attacks.	Mist. ferri co., dec. aloes.		
45[1]	F.	17	Entire body.	Sixteen weeks.	Fright.	...	Swallowing very difficult; had constant rotation and pronation of both arms; and at times peculiar movements of both upper eyelids; constant jerking of entire body.	Potassio-tart. of antimony; blister to neck; wine; subsequently assafœtida in mixture and in enemata.	...	Would fall down on trying to sit up; had great pain in the head and dimness of sight of right eye. When in bed constant extension of both legs in a shuffling way.

[1] Was in-patient under Dr. Page. (Elizabeth T—, admitted May 12, 1858.)

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46	M.	12	Right.	...	None.	...	...	Saccharated carb. of iron, senna, calomel and jalap; subsequently sulphate of zinc.	Three weeks.	Two week. Result unknown.
47	F.	6½	...	Four days.	Has ascarides.	...	...	Scammony and calomel, quinine and steel, shower baths; subsequently sulphate of zinc added.		
48	F.	11	...	...	None known.	...	...	Mist. ferri comp., shower baths, aperients.	Eight weeks. Recovered.	
49	F.	12	Left.	Four weeks.	...	...	...	Steel wine, calomel and scammony, shower baths; quinine, steel, and zinc subsequently.	Seven weeks. Recovered.	
50	F.	11½	...	...	Has a systolic cardiac bruit at base, but never had rheumatic fever; has many decayed teeth.	...	...	Calomel and scammony, sulphate of zinc, iron and quinine.	One week. Result unknown.	

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6

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
51	M.	9½	...	...	Had worms a year ago.	...	Muscles of the left arm and shoulder atrophied, and the bone very atrophied also. Prominence of sternum and costal cartilages. Subject to headache.	Steel wine, jalap, shower baths.	Eight weeks. Recovered.	It may be supposed that the chorea was independent of the cause of the atrophy, which has been since one year of age. Left leg gives way, but not atrophied.
52	F.	21	Left.	Two weeks.	Fright.	...	Stammers and talks "thick." Pain in left of head and down arm and leg. Drags left leg much; at times has palpitation of heart.	Calomel and scammony, mist. ferri comp., blister to neck.	Two weeks.	Can only get the left arm to a right angle by much effort.
53	F.	13	At first right side affected, but now the left.	Fourteen weeks.	None.	...	...	Quinine and steel, shower baths; sulphate of zinc added subsequently.	Eight weeks. Recovered.	

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
54	M.	15	Left.	Two weeks.	None.	...	Had slight convergent squint of right eye ever since three years of age. Had feeling as "of blood racing cold down the back."	Calomel and jalap, arsenic and potash.	Five weeks. Discharged very much improved.	
55	F.	14	Left.	...	...	...	...	Mist. ferri comp., shower baths; sulphate of zinc, quinine and steel.	Ten weeks.	
56	F.	9	Both sides.	Nine days.	None.	Had similar attack twice before.	...	Saccharated carb. of iron, calomel and scammony.	Two weeks. Then described as "walking and talking better." Left off his visits.	
57	F.	10	Both sides.	One month.	Fright. Had lumbrici some months previously.	...	Had twitchings of the whole body; constantly making a noise; "jumping, and hallooing," as friends said. Shouted much in sleep.	Steel wine, calomel and scammony, sulphate of zinc and valerian.	Seven weeks. Was much quieter in three weeks. Left as being "well enough."	

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
58	M.	13	Right.	...	None.	...	The mouth much drawn to the right side. Speech affected. Eyes and root of tongue affected.	Calomel and scammony, sulphate of iron, quinine and zinc, up to four grains for a dose.	Six weeks. Discharged, having only very slight movements at times.	Sickness caused by the zinc.
59	F.	20	...	Previous attack some months before.	...	...	Much spinal tenderness, also furred tongue and constipation.	Mist. ferri and dec. of aloes; dry cupping to dorsal region; aloes and myrrh, shower baths, quinine and steel. Stimulating embrocations to back.	Ten weeks. Very greatly relieved.	
60	M.	10½	Both sides, but left one chiefly.	Two weeks.	Fright.	Had an attack one year before, lasting three or four months.	Foams at the mouth and loses power of speaking, but not the senses.	Mist. ferri comp., steel wine, and subsequently zinc, quinine, and iron; calomel and jalap; cod-liver oil subsequently.	Fourteen weeks. Recovered.	

61	M.	12	Right.	Two months.	None.	...	...	Quinine and steel; senna; steel wine subsequently.	Two weeks. Result unknown.	
62	F.	15	Left.	Six weeks.	Ditto.	None.	Sometimes cannot open her jaws to talk, and spasm of the muscles of the left jaw. Often moves whole body abruptly, as a child will do in a pet.	Croton oil, saccharated carb. of iron, the sesquioxide of iron, and latterly sulphate of zinc.	Four weeks. Result unknown.	Partly hemiplegic on right side when first taken ill; used to beat her hands in the night. Was excited at one time, as if going out of her mind.
63	F.	9	Both sides.	Nine days.	Ditto.	Had two attacks previously, and then on the left side.	...	...	Two weeks. Much improved.	
64	F. Married.	43	Left.	Fourteen months.	Ditto.	None.	Much headache at times, and has often "black spots" in the sight. Leucorrhœa and irregularity of catamenia, menorrhagia succeeded.	Quinine and steel, and valerian; shower baths and galvanism; later on gallic acid. Heat and cold alternately applied to the neck.	Four months. In six weeks was much quieter.	Worse after shower baths. Had 'queer' and unpleasant feeling at back after the ice application.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
65	F.	11½	Right.	Six weeks.	None.	Had chorea for seven years every autumn, lasting from September to Christmas.	Pupils dilated.	Calabar bean, the tincture, about 75 drops thrice a day; scammony and calomel.	...	Not so well after shower baths. Had nausea, headache, and giddiness.
66	M.	10	Left.	...	Fell downstairs two months previously.	None.	Had had scarlet fever three months before, and been weak in left hand for six weeks. Very little power in left arm and leg. Right pupil rather the largest.	Tincture of the calabar bean, ℥j, reduced to ℥ss at a dose, owing to vomiting. Castor oil.		
67	F.	12	Both legs, and only the left arm.	Six weeks.	None.	Previous attack fifteen months before, and another one when æt. 7.	At times has palpitation of the heart.	Tincture of calabar bean, up to ℥iss ter die.[1] Syrup of iodide of iron and quinine subsequently.	Three months. For the first two months no better; began to amend after a week's action of the iron. Discharged at last as quite well.	

[1] The strength of this tincture was in proportion of one drachm of the bean to one ounce of rectified spirit.

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68	F.	12	Right.	One month.	Ditto.	None.	Right pupil larger than left. Heart's action quick and irritable, but no bruit; pulse quick and feeble; "quite a job to feed herself."	P. jalap. co.; tinct. of calabar bean up to ℥j thrice a day.	In six weeks was "almost quite well," the right leg only "giving a little." At last discharged as quite well.	
69	F.	9	Right.	Six weeks.	Ditto.	Ditto.	...	P. Jalap. co. quinine and iron.	Eleven weeks. Discharged as quite well.	
70	F.	7	Both sides.	...	Rheumatic attack preceded chorea. No cardiac bruit remaining.	...	...	Dec. aloes comp., steel wine, sulphate of zinc, quinine and iron.	Two weeks. Discharged as quite well.	
71	F.	18½	...	Six months, and very ill for one month previously.	...	...	Right pupil rather smaller than left, both acting well; right eye opened more fully than left; speech "thick and weak" after long talking.	Rhubarb and magnesia, quinine and iron.	Four weeks. Left off attendance, and much better in all ways.	

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No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
72	F.	8	Left.	Two weeks.	Not been quite right since illness five mths. previously—"a kind of a fever." Slight obscuration of the last cardiac sound remaining.	...	...	Calomel and scammony, cod-liver oil, steel wine.	Three weeks. No further appearance.	
73	F.	11	Right.	...	Has number of ascarides.	Had some severe attacks three years previously, and never quite recovered from afterwards.	...	Calomel and jalap, quinine and steel.	Five weeks. Result unknown.	
74	F.	19	Left.	Four months.	Fright.	Previous attack four years previously. Had "low fever" a yr. previously.	Has less power in the left arm and leg and left side of face than on the right. Right pupil rather larger than the left one.	Aperients; quinine and steel, to which sulphate of zinc was subsequently added.	Five weeks. Somewhat improved.	Mother had chorea, and was treated by Dr. Bright, of Guy's Hospital, and since has had the mouth drawn to the right side.

75[1]	M.	9½	Both sides, but left one chiefly.	Two weeks.	None. Had "a fit four years previously."	...	Grasp with left hand much weaker than on other side, and want of power in left side of face. *Sensibility of skin of left arm and leg diminished.* No twitching of muscles of neck.	...	In hospital three weeks. Went out much the same.	Present attack began with shaking of left hand, and then the leg and side began; vomited once or twice after illness began.
76	F.	6	Entire body.	Six years.	Ditto.	...	Had lost much flesh of late.	Sulphate of zinc and iron, scammony and jalap. Subsequently the Calabar beam, and then strychnia.	Improved for three weeks, and then became stationary.	Had been taking the sesquioxide of iron throughout illness until she came into hospital.
77	F.	8	Both sides.	Two weeks.	Fright. Had loud systolic bruit at the base of heart, following the course of pulmonary artery. Never had rheumatism.	...	...	Sulphate of zinc, increased to large doses; iron and magnesia, scammony and jalap.	About a month. Speech became much better; he altogether improved very greatly.	

[1] No. 75 was an in-patient under Dr. Page whom I watched; and Nos. 76 and 77 under Dr. Fuller.

No.	Sex.	Age.	Side affected.	Duration of present attack.	Probable or assigned cause of the chorea.	Whether previous attack existed.	Peculiarity of symptoms.	Treatment.	Length of hospital attendance, and results.	Further remarks.
78	F.	15	Both sides.	Six or seven weeks.	Had fright, which made her worse. No original cause.	No.	Movements confined to head and arms.	Calabar bean. This changed for aloes and steel. Afterwards sulphate of zinc up to 9-grain doses.	Seven weeks. Improving.	Catamenia been scanty, and only twice in ten months.
79[1]	F.	11	...	Ten weeks.	Slight blowing murmur at apex of heart with first sound. Had never had rheumatic fever.	Ditto.	...	Sulphate of zinc, iron, and magnesia, and subsequently strichnia added. Also shower baths.	Between six and seven weeks.	The friend said there had been slight paralysis of the right arm since she was quite young, but of this evidence was very slight. She had lost all power in the adductors of the right thumb.
80	F.	16	Both sides.	...	Had mumps, and three weeks afterwards became hysterical and choreic. Heart-sounds mature; never had rheumatic fever or experienced fright.	Ditto.	Decidedly hysterical. Chorea began with movements in hands and face.	Sulphate of zinc, iron, and quinine. Shower baths, which had quickly a good effect.	Six weeks. Got quite well.	Catamenia always very abundant and frequent, and long standing.

[1] Was an in-patient under my care, admitted June 19, 1867.

Reviewing the contents of the foregoing Tables, I will now proceed to summarise some of the information which they afford; and first of all, with regard to the SEX of the patients. In giving the details of the sixteen fatal cases of chorea, in the January number, page 223, the preponderance of females over males was, it will be remembered, very conspicuous, the proportion being fourteen of the former to two of the latter.[1] Out of the eighty non-fatal cases in the Tables it will be seen that the females are very much in the majority, there being sixty-one of this sex to nineteen of males, *i.e.*, rather more than three to one—a proportion which strongly suggests that there are circumstances in their case which render them especially prone to the affection.[2]

As respects AGE, I find that out of the eighty cases all, excepting fourteen, were under the age of sixteen. Eleven is the age in which the greatest number were affected, viz., thirteen.[3] Up to this age the numbers increase pretty uniformly from the age of eight, and decrease to the age of fifteen, being at the age of eight and nine, six in number; at the age of ten, eight in number; and again (on the outer side of eleven), being nine at the age of twelve; seven at the age of fourteen; and six at the age of fifteen. The youngest was five years of age, and that was the only instance under the age of six.[4] The only two cases which were above the age of twenty-one were twenty-four and forty-three years old respectively. Thus it is very clear that circumstances of age as well as of sex have marked influence in connection with the affection.[5]

[1] Taking the fatal cases of chorea registered as having occurred in England during several years, I find that the proportions as regards sex were as follows:—In 1848, 24 females to 14 males; in 1849, 24 to 10; in 1850, 39 to 21; in 1851, 67 to 10; in 1852, 54 to 19; in 1854, 28 to 20; in 1855, 47 to 22; showing in some cases a much higher figure for the females in comparison with the males.

[2] Dr. Willshire, who has had much experience in the diseases of children, states (see 'Med. Circ.,' Feb. 15, 1865, p. 101) that chorea is much more difficult of treatment in boys than in girls. It is curious to observe that Hamilton, whose great panacea for chorea was purgation, hints that the disease is more difficult of cure in girls, *because* the structure of the female pelvis allows of greater opportunity for the accumulation of feculent matter.

[3] The influence of youth in predisposing to chorea is also apparent in the lower animals. Youatt observes that in dogs it oftenest occurs in young ones, and after the distemper.

[4] The patient in case 17 had had an attack of chorea, when aged three and a half years.

[5] In the 'Register of deaths in England for 1839,' p. 121, a case of chorea, which proved fatal at the age of seventy-five, is recorded. In the 'Lancet,' for June 1, 1861, p. 530, Mr. Ellis records a case of chorea in a gentleman, aged seventy-five (the third attack). The movements came on at irregular intervals. He had a daughter who was epileptic, and a son who was insane. In the 'Medical Times,' for July 25, 1863, is reported a case of chorea, under Dr. Brown-Séquard's care, of the age of sixty-eight, and also one under Dr. Peacock's care, of the age of fifty-seven, the results of alarm. At the same place a case is given of chorea, from which the patient, aged twenty, had been suffering nearly all his life. Such a case, recorded by Rostan, is also alluded to in note at foot of page. In the

As respects the PARTS AFFECTED, it does not appear that one side was much more decidedly affected than the other. For, excluding ten cases in which no mention of this matter has been made, I find that in twenty-four cases it is stated that the *right* side only was affected, whilst the *left* alone was affected in twenty; and in twenty-five cases it is recorded that *both* sides were affected, although in some instances one or other side was more involved than the opposite one. In one or two cases the movements appear to have changed from one side to another, as in case 53. In cases 1, and 3, and 35, in which the *right* side was affected, both sides had been affected in a previous attack; in case 5, in which the right side was affected, it had been the left side in a previous attack. In case 63, in which both sides were affected, the affection had been one of hemichorea on the left side in a former attack.[1]

Respecting more restricted localisation of the choreic movements in certain cases (taking any period of the attack), the following were worthy of note. In case 19, the first symptoms were confined to the mouth and tongue; in case 25, they were confined to the muscles of the face and eyelids;[2] in case 80, the hands and face were first affected; in case 29, the hands

'British Medical Journal,' for May, 1867, a case of choreic movements in a woman, aged seventy-four, under the care of Mr. Hutchinson and Dr. Hughlings Jackson, is detailed. Mr. Henkelmer describes in the 'Deutsch. Clinik,' 1859, 52, the case of a man, aged eighty-four, who had a choreic affection of the arm and leg of one side, following an attack of numbness in the arm and confusion of the mind, after drinking. Dr. T. Thompson quotes cases of chorea at the age of seventy and eighty, recorded by Dr. Powell and Bouteille; and Trousseau quotes three or four cases of chorea at the ages of sixty and seventy, and also one described by Roger, at the age of eighty-three. On scrutinising the ages of 39 fatal cases, which are registered as having occurred in England, in 1839, I find that they were as follows:—Under four years of age, 1; under five, 5; between five and ten, 12 cases; between ten and fifteen, 7; between fifteen and thirty, 1; between thirty and forty, 1; between forty and forty-five, 2; between forty-five and fifty-five, 2; between fifty-five and sixty, 2; between sixty and sixty-five, 2; between sixty-five and seventy-five, 3; between seventy-five and eighty, 1.

[1] Romberg, in his work on 'The Nervous System,' vol. ii. p. 56, observes that, in the majority of cases both sides of the body are affected, and that the statement of Rufz and others, that the left side is more violently and more frequently affected than the right has not been confirmed. He quotes from Wicke, who found that out of fifty-eight cases, the left side was affected in twenty-three, and the right in twenty-six; that in one case it passed from the left to the right. Trousseau observes that most commonly unilateral chorea is on the left side. Bond, in an interesting article on chorea, in the 'Brit. and For. Med. Chir. Rev.,' July, 1860, observes that, according to Seé and Grisolle and others, including himself, chorea generally begins in the left arm, and that the hemiplegic form generally occupies the left side, which, if true, Dr. Bond suggests may be owing to the fact that the left limbs being, as a rule, subordinate to the right, are of weaker organisation, and therefore more liable to the influence of disturbing agencies.

[2] I have never seen a case in which the muscles of the *eyeballs*, so as to produce squinting, were affected, though of course we often had rolling about and distortion of the eyes. Youatt (op. cit., p. 121) mentions that in dogs sometimes the muscles of the eye are affected; I suppose he means the eyeballs. Trousseau mentions a case of chorea in which strabismus existed.

were first affected, and then the legs and the left side of the face, only three days before attendance, the eyes and the other side of the face remaining unaffected. In case 33, the movements consisted in "opening the mouth about every minute." In case 78, the movements were confined to the head and arms. In case 43, whilst the whole of one (the right) side was affected, it was only the muscles of the neck of the left side which were affected. In case 53, the right side was first alone affected, and afterwards the left alone. In case 67, both legs, but only the left arm, were affected. It has been observed by some authors that choreic movements are more localised in the case of adults. Youatt says that in the dog they are often confined for long to one limb. The stringhalt in the horse, a local affection, has been looked on by some as analogous to choreic movements.

I now pass on to the apparent CAUSES of the choreic affection, including in one consideration those causes (determining or exciting) which by friends were assigned or thought probable; and also those which may be looked upon as being predisposing or remote. I find that out of the eighty cases, in ten no mention is made of any causation whatever, and therefore no conjecture can be formed regarding them. In thirty-five it is recorded that no cause of any kind was suspected by friends. *Fright or mental emotion* being often thought to act as a determining influence, I find that in five cases this cause alone was assigned. In another case (No. 78) it was said to have aggravated the already existing affection. In an additional case (No. 24), fright and quarrel, following an attack of rheumatic fever, which had existed three months before, were assigned causes; and in six more cases fright and the presence of the common ascarides, or of lumbrici combined, were thought to have been influential in producing it.[1] As respects the presence of *intestinal worms*, in addition to the cases above alluded to, eight were said to have worms at the time of commencement of treatment, and three had formerly had them. I have notes of a case under Dr. Bence Jones's care, in the hospital, June, 1858, who passed a large lumbricus whilst in the hospital, and in whom there was loss of power in the right arm and leg, thought to be choreic.

As respects *rheumatism* or *rheumatic fever*, or *cardiac affection*, in connection with the disease, it appears that in eight cases rheumatic

[1] In the Registrar-General's return for the week ending February 1st last is the record of a fatal case of chorea in a girl, aged twelve, "occasioned by the fright produced by the explosion," *i.e.*, the Clerkenwell Fenian explosion. In the same return for the week ending February 22, is the record of the death of a woman from "paralysis, accelerated by fright from the same explosion." We not long ago had a girl, aged sixteen, at St. George's Hospital with chorea, which was brought on by an attempt on the part of a young man to strangle her, by seizing her at the throat. The man had had a summons directed against him by the magistrates, on the testimony of neighbours, to the committal of the assault and of its leading to her illness.

fever had existed. In one of these cases (No. 8) no mention of the state of the heart's valves has been recorded; whilst in five cases it is stated that the cardiac sounds were natural, and in one only (No. 12), (and in this case it was somewhat doubtful whether the fever spoken of had been rheumatic), were the cardiac sounds interfered with, there being slight obscuration of the second cardiac sound.

In cases 50 and 77, it appears that a systolic bruit existed at the base of the heart; but in both cases it was affirmed that no rheumatic fever had occurred. In case 79, a systolic bruit at the apex of the heart existed; but there had been no rheumatic attack. Most likely in several cases there had been unnoticed temporary cardiac bruits, arising either from an anæmic state of blood, or from irregular action of the fleshy columns and tendinous chords of the heart.

In case 18, it appears that the attack was preceded by *palpitation* of three weeks' standing, but it is stated that there had been no rheumatic attack. Pains, however, in the limbs and palpitation had been experienced.

Dr. Chambers found that out of thirty-three cases of chorea in his books, in six the affection either began during rheumatic fever, or followed immediately after it, or else rheumatic fever succeeded to the chorea. He, however, made out no connection between the chorea and previous valvular or pericardial tension of the heart, only one of the six above cases having any cardiac affection. He justly, however, observes that, "considering how very common inflammation of the central organ of circulation is in rheumatic children, and that it is at this age that chorea usually occurs, on the mere doctrine of chances they would (*i.e.*, chorea and heart disease) often coincide." In the statistics of the London Hospital for 1864 (see 'Hospital Reports,' p. 388), it is stated that out of twenty-four cases of chorea twenty had a systolic bruit at the apex of the heart, persistent in all but two; and in the statistics for 1865 ('Reports,' p. 422), it was said that out of thirty-seven cases, 15 or 40½ per cent. had valvular disease of the heart.

As regards *derangements of the uterine system*, I find that in one case (No. 3) the attack followed a miscarriage, and in five cases it is stated that the catamenia had been scanty and irregular, or over-abundant and too persistent.[1] Looking to what may be termed

[1] It will be remembered that, among the fatal cases before recorded, two were related in connection with pregnancy. Of these, I find that one (No. 1) had been previously related by Dr. Lee, in his 'Clinical Midwifery,' 1848, p. 112. Dr. Barnes has recently informed me of a patient who had experienced several attacks of chorea which came on at various intervals always during pregnancy. In the early part of last year we had, in St. George's Hospital, under the late Dr. Page's care, a patient with chorea who was pregnant. In the 'London Obstetrical Society's Transactions,' vol. vii, p. 102, are two cases related by Dr. B. Woodman, showing the combination of chorea with pregnancy; one, the case of a young

alleged causes of MISCELLANEOUS character, in case 40, the affection was thought possibly to have been connected with *sores on the head*.[1] In case 75, a fit had occurred, but a long time (four years) previously; in case 22, the patient had fallen down stairs three weeks before the attack came on; and in case 66, a fall had occurred two months previously. In both the latter cases the fright of the accident may have been instrumental in causation. In case 74, so-called low fever had existed; and in case 80, the attack followed, at a short interval, an attack of mumps.

In cases 22 and 74, the mothers of the patients had had chorea; and in case 11, it was stated that a sister had had it, possibly from imitation. Authors quite recognise the *hereditary* character of chorea in some, though rare cases. Thus Bright mentions it in page 469 of his work;[2] and Seé says he has found the disease to

woman who had constantly had chorea from the age of seven to thirteen, in his own practice, and one following fright, in Dr. Down's, at the London Hospital. He expresses his belief that choreic movements are chiefly reflex, and connected with the sympathetic nervous system, and alludes to a third case of chorea in a pregnant woman which he had heard of. I have before alluded to Dr. Levick's paper (in the 'American Journal of Medical Science,' January, 1862, p. 40), giving the details of three cases of chorea and pregnancy associated. Of these cases one was fatal, and in this it is said that "the brain was found very much congested throughout; the heart small and firm, with a bead-like deposit on the aortic valves." In these cases the choreic movements, though mitigated, did NOT come during sleep. Dr. Levick quotes five cases of chorea, combined with pregnancy, from Dr. Ingleby ('Lancet,' 1840, p. 783); also two such cases from Dr. M. Duncan (Ed. 'Med. and Surg. Journal,' January, 1854); and contain cases of association of convulsive movements and pregnancy, described by Shenkins, in 1609 ('Observ. Med. Rer.,' De Spasmo, pp. 128-9). I would here allude to a paper in Virchow's 'Archiv. f. Path. Anat.,' Bd. xxiii, 1862 (Hft. 1 and 2, p. 149), "Ueber Chorea Gravidarum," by Dr. Mosler, in which he has collected and analysed twenty-one cases of chorea in pregnant women. They were chiefly of an age between seventeen and twenty-four. Of these five had had chonic previously, and fourteen were primi-paræ. In eight cases fright, or other mental emotion was assigned as the cause. The period of pregnancy at which the chorea commenced varied, but in seven cases it was at the second, and in eight cases at the third or fourth month. It was seldom that one side only of the body was affected; in many cases the chorea was accompanied by epileptiform convulsions, and in most there had been hysteria previously. In very few was there any intellectual aberration. Four aborted and three were confined before the proper term; three times the abortion was followed pretty rapidly by cessation of the choreic movements. In five the chorea remained until the end of pregnancy, and in nine cases recovery occurred before that time. Treatment was chiefly by iron and zinc. These cases include several of the cases which I have alluded to, and were recorded by Ungen, Frank, Hand, Jeffrey, Bezold, Romberg, Helfft, Aran, Duncan, Ingleby, Lever, Scanzoni.

The whole subject of the connection between menstrual and uterine irregularities, suppression of the menstrual function, &c., and so termed nervous diseases, even insanity, is of the highest interest, and both worthy and capable of much greater development and attention than it has at present received.

[1] In the 'Brit. Med. Journal' for May 17th, 1862, a case of chorea, immediately following a severe burn, is related as being under Mr. Craven, of Hull; recovery ensued before the burns healed.

[2] Dr. Day, in his 'Clinical Histories,' p. 103, alludes to the more than ordinary

be hereditary in very many cases. They also allow that *imitation* may be, in certain instances, instrumental in its propagation. I find that Bricheteau describes the case of eight patients, within a space of six days, contracting the disorder after the admission of a severe case into the ward, requiring instant separation of the patients;[1] and Chambers, in his 'Lectures,' before quoted, records the interesting case of a boy, aged sixteen, who had been operated on for stricture, and accidentally placed in a bed opposite to one occupied by another boy with chorea. He soon began to imitate the movements which he witnessed, although moved into another ward, and eventually died, abrasions and pericarditis (possibly due to pyæmia) having come on. I may mention here that we lately had two patients with chorea in the same ward, in St. George's Hospital (as I am informed by Dr. Archer, who was attending to the cases in the ward). One was much worse than the other, and the severer case was at one time so injuriously acting upon the other, whose imitative powers appeared considerable, that they had to be placed in separate wards.

As respects the fact of the patient's having had PREVIOUS ATTACKS or otherwise, I find that (excluding thirty-three cases in which no mention of this has been placed on record, and one case (No. 33) in which it is doubtful), there are nineteen cases in which it is stated that no previous choreic attacks had been experienced, against twenty-five in which previous ones HAD occurred, and out of these five (viz., Nos. 9, 10, 56, 63, and 67) had suffered from TWO previous attacks. In case No. 17, the patient had had SEVERAL attacks since the age of three and a half years. Case No. 65 had had chorea every year for seven years, lasting from September to Christmas. In order to prevent relapses, Sydenham, who bled regularly for the disease, enjoined bleeding and purging for a few days on the year following, at the same time of the attack or

frequency amongst the Jews of chorea as an argument in favour of the existence of an hereditary tendency to the affection; and he has obligingly furnished me with the following CIRCUMSTANCES referring to this supposed prevalence of chorea among the Jews. He observes—

"1. In 1834 I heard the late Dr. Addison (Guy's) say, during some some bedside clinical remarks, that he had noticed 'chorea' to be very common in Jewish families.

"2. Dr. Stiebel says that chorea is particularly frequent amongst the Jews (vide 'Wochenschrift für die gesammte Heilkunde,' No. 1, 1837); also the 'Brit. and For. Med. Chir. Rev.,' October, 1837, p. 504.

"3. In 1842 I attended a family of Jews consisting of father, mother, and five children—four girls and one boy; all the four girls had 'chorea,' three of the number being attacked at one time. The mother had had chorea when a child, and the father's mother had also suffered from the same affection.

"4. An intelligent old Jew (gentleman), well up in the history and peculiarities of his nation, told me some short time before his death, which took place in 1865, that 'his people were often attacked with St. Vitus's dance, and that, when in Germany, he had known whole families to be affected with it.'"

[1] 'Gaz. des Hop.' 1863, No. 46.

earlier. Heberden also alludes to the fact that a "little tendency" to the recurrence of chorea in some cases has been felt every spring and autumn for three or four years.

Case No. 73 is a peculiar one, inasmuch as it was stated that the patient had "had some severe attacks three years previously, and never quite recovered from them." In several instances the attacks had been of long standing. Thus, in case 4, they had gradually been coming on for four years; in case 25, the symptoms had existed off and on for eighteen years; and in case 76, for six years. In none of these long-standing cases have we indications showing that any cerebral or spinal lesion had existed.

I will now pass on to consider such cases as presented any PECULIARITY IN THE SYMPTOMS which it seems desirable to take notice of. In addition to other interests, this inquiry might have special value with respect to the question as to whether the choreic symptoms had reference, in any cases, to organic disease of the central nerve organs.[1]

Taking into consideration the state of the MIND, in only two cases (Nos. 6 and 34) have we mention of any complication. Even in

[1] To the subject of choreic movements having their source, in some cases, in obvious disease of the brain or spinal cord, I alluded at pages 21, 22, and said that I purposed to make an inquiry into such cases as I could find, in which organic lesion existed. I may here, in passing, allude to an interesting case, described by Youatt (op. cit., p. 122), of a dog which had chorea complicated with "fits," and also had a peculiar tendency to run "round and round." After death, neither inflammation nor softening of the brain were found, but two spicula of bone were met with, one sixth of an inch long, projecting from the inner surface of the parietal bone, near the sagittal suture. The brain was, to all appearance, natural in substance. In the footnote to page 22 I have alluded to the supposition of Skoda's, that an exudation in the nervous structure may be the cause of chorea. I find that a case of chorea in a man aged 19 is described in the 'Wien. Wochenbl.,' xvii, 1861, 35 and 36, by Stoffella, in which, along with softening of the spinal cord young connective tissue-formation was met with in the form of fine greyish-coloured opaque stripes, the grey substance of the cord being very fatty. It seems that Rokitansky found similar areolar-tissue-formation in the spinal cord in *certain cases of tetanus and of hyperæsthesia*. I have at hand notes of the following recently recorded cases of fatal chorea in which lesion of the brain or spinal cord was found after death, or suspected:—Bouchut ('Gaz. des Hop.,' August, 1863) describes a case of semi-chorea with incomplete hemiplegia in a child, following a fall upon the head and unconsciousness. The strabismus, deafness, loss of memory, and pains led to the supposition that cerebral congestion was the cause of the chorea. The patient recovered. At the Middlesex Hospital, in 1863, was a fatal case of chorea, under Dr. H. Thompson's care, the result apparently of fright. After death the substance of the brain generally was found much softened, especially the anterior pillars of the fornix and the septum lucidum, and the left side was more softened than the right. Considerable softening also existed of the spinal cord from the third or fourth to the sixth and seventh dorsal vertebræ, and the cervical swelling was softer than natural (see 'Med. Times,' July 25, 1863). The reader of Dr. Copland's 'Dictionary of Medicine' may remember that, in 1821, he recorded a case of chorea, complicated or alternating with rheumatism, and with metastasis to the heart and spinal membranes, which, after death, were found to be covered with coagulable lymph, &c.

case 6, complication is not quite clear, and in case 34 it was only in a former attack that the mind had been affected. In case 62, mental excitement, "as if she was going out of her mind," had existed at one time. This comparative immunity from any affection of the mind in these choreic cases is perhaps worthy of comment, as some authors have spoken of the not unfrequent alliance between the two.[1] In cases 44 and 80, the patients had been more or less liable to hysterical attacks; it may be remembered that in two of my fatal cases, hysteria had co-existed. Dr. Chambers also records a case (op. cit., p. 365) of chorea in which hysterical attacks had occurred.[2]

Regarding PARALYTIC symptoms, in eleven cases we have distinct mention of paralysis of some kind or other (viz., in cases 18, 19, 21, 43, 52, 58, 62, 66, 74, 75, and 79). In this category I have placed only those cases in which actual want of power in the muscles of the limbs or face existed, and not those cases in which muscular weakness resulted as a consequence of want of power of direction of and of harmonising the muscular action.

In cases 30 and 75, positive anæsthesia existed,[3] and in the latter

[1] Marcè, mentioning their frequent coincidence (see number of this 'Review' for July, 1859, p. 256), describes the association in a systematic manner as being of five varieties, as follows:—1. Troubles of moral sensibility, irritability of temper, sadness. 2. Troubles of intelligence, loss of memory, mobility of ideas, and inability to fix attention. 3. Hallucinations, between waking and sleeping, and of the sight chiefly. 4. Maniacal delirium, which, if recovery occur, may leave the mind affected. In the 'Year Book of the Sydenham Society for 1865,' p. 84, are related two highly interesting cases, recorded by Thore, and quoted from the 'Ann. Med. Psych.,' 1865 'a which insanity followed chronic attacks of chorea; and allusions are made to the writings of several well-known authors, showing that various kinds of intellectual and emotional insanity may occur in cases of chorea, though it appears that Thore considers that these mental affections can hardly depend upon the choreic state, but are chiefly caused by coincident diseases, such as typhus, rheumatism, or chlorosis. Dr. Inman, in his 'Foundation for a New Theory of Medicine,' 1861, p. 153, observes that "in chorea we have at times a mental prostration, amounting almost to idiocy." Romberg, vol. ii, p. 57, observes that in chorea, "except in complications, no psychical disturbances are manifested." Trousseau, on the other hand, observes that in every case of chorea there is, with few exceptions, more or less marked impairment of the intellectual faculties.

[2] I have now a boy in St. George's Hospital with chorea, who has had two or three attacks of chorea, with long intervals previously, and his mother assures me that on each occasion he has during the attacks forgotten "all his learning," so that he actually had to be taught his alphabet afresh after each attack. He has never had any fright nor rheumatic attack, but has had ascarides.

[3] Trousseau speaks of diminution of sensibility existing in most cases of chorea, and of anæsthesia, when it exists, being greater on the most convulsed side. I have lately had related to me by Dr. Ilott, of Bromley, a case of chorea, in which the movement was confined to the right arm, which "was constantly in motion, unless strapped down to the body; when relieved, the movement would instantly begin. It was almost entirely *devoid of sensation* during the earlier part of the time. This want of sensation gradually improved, and the movement became less violent." It seems that "the improvement dated from a time when the patient had a peculiar thrill down his arm, similar in character to one he had at the commencement of the attack." From this time the move-

case there was loss of power in the left arm and left side of the face. The atrophy of the muscles and of the bones of the shoulder, in

ments were much "more under control, and it was only when he became excited that he had any twitching. He has now quite recovered, and is employed as a French polisher. The medical treatment consisted chiefly in the use of iron in various forms." The patient was an orphan boy, aged 13, and of average ability, as Mr. Cattlin, of Brighton, who knew him, informs me. He has also told me that the boy had paralysis during his first dentition, and also, he thought, had been the subject of tapeworm. He had been under Dr. Gull's care, at Guy's Hospital, and also under Dr. Hare's care. The case reminds one of those cases described by authors, in which the movements consist of "malleation." The following case, described in Dr. Charlton's book 'on the Bath Waters,' p. 53, may form a pendant to that of Dr. Ilott's:—A woman had a fright, which first brought on convulsions and great pain in the stomach. Afterwards she was the subject of a peculiar involuntary motion of the right arm. This movement was perpetual, "like the swing of a pendulum," raising the hand, at every vibration, higher than the head, and seemed to alternate with convulsive movements. The motion of the arm always ceased during sleep, but returned immediately on waking, and continued all day. She got well, as was supposed, under the influence of opium, given in considerable doses.

Dr. Parkes, in 1861, had a case under his care at University College, in which the movements were limited to the right arm, and were like those produced by electrical shocks. Sometimes there was *anæsthesia* of the affected arm, and once a tendency to twitching of the opposite arm. It was described as being like the cases recorded by Dr. Pignacca under the name of electrical chorea, given by Dubini, of Milan, and which are probably epileptic in character (see 'Lancet,' March 2, 1861, p. 214). Dr. Parke's patient recovered. A case of "chorea electrica traumatica" treated successfully by wet-sheet packing is quoted in 'Schmidt's Jahrbüch,' 1860, p. 305.

Along with these cases also may be quoted one described by Dr. Aspray, in the 'Lancet,' for July 15, 1865, p. 65, in which the patient, a female, was affected by violent choreic jactitations, first of the right arm, which was thrown upwards and downwards, from the face to the knee, occasionally changing to the rotatory motion, and then of the opposite arm. The patient had no return of the attacks. She had been suffering from constipation.

In connection with the above cases, mention may also here be well made of the case described by Dr. Sanders, in the 'Edinburgh Med. Journal,' for May, 1865, under the name of "pseudo-paralysis agitans," or "spinal chorea" (?) a case belonging to the class "tremores." "The case bore a general resemblance to those of chorea," but "really differed entirely from this affection," the movements being shaking, oscillating to and fro by the alternate action of antagonistic muscles, repeating themselves rhythmically and usually symmetrical. The predisposing cause of the affection seemed to be an accident some months previously, and the existing cause, fright, occasioned by a second fall; and Dr. Sanders thought that the affection depended on a weak and excitable condition of the motor centres in the spinal cord, due to anæmia of its grey substances. Sometimes no doubt the diagnosis between true chorea and other forms of morbid muscular movements is difficult. Dr. T. Thompson (op. cit.) quotes a case described by Dr. Dufour and Rennes, in which the choreic movements were "zigzag," in character, and were mistaken for those of drunkenness.

It has been remarked by Dr. Elliotson, that when the disorder is confined to the muscles of one arm or of the hand, and especially in the adult, he had never known the disease cured.

Although not an instance of chorea, but rather of hysteria, I may here record the following interesting case which I witnessed:—The patient, a young lady, had been watching her dying father, whose respirations were very loud and of rather a peculiar rhythm. After his death, the daughter, stunned as it were by her loss, and hardly realising it, could not shed tears, but for some time (three or four hours) continued pacing up and down the room with a peculiar movement of the head,

case 59, are worthy of notice; but, dating so far back as they do, they appear to have had no connection with the choreic state. In case 79, there was atrophy of the adductor muscles of the thumb on both sides.[1]

Looking at the condition of the PUPILS of the eyes, I found that in many cases dilatation of both pupils existed, as is commonly noticed by observers of chorea; but of this appearance I have not made special note in my cases. In the following cases, however, disparity between the two pupils was noted (a much more important phenomena, I need hardly say, than equal dilatation of both), viz., in cases 2, 20, 61, 71, and 74; and in all of these instances it is curious to note that it was the *right* pupil which was dilated more than the left.[2]

Respecting PAIN experienced, I observe that, excluding such pain in the limbs and joints as may be looked upon as being rheumatic, &c., we have notice in the following cases of distinct pain in the head, viz., in case 10 (in which, apparently, some syncope co-existed) in cases 16, 17, 19, and 64. In case No. 59 "much spinal tenderness" was complained of.

Regarding acknowledged affections of VISION, such seem to have existed in No. 17, where "something before the eyes was always noticed;" and in case 45, where dimness of sight of the right eye, along with headache, existed; and in No. 64, where "black spots" in the sight were spoken of.

As respects any connection between the affection and *sleep*, it will be admitted that in cases 16, 17, and 33, the choreic movements were wont, more or less, to continue during sleep; whilst in case 36 the patient was said "to plunge when asleep in bed;" and in case 43 the eyes would "twitch much" during sleep. In case 24, the patient was said to be "always worse in bed when first roused up from sleep."

In case 60, "FOAMING at the mouth" was described as existing; and in case 40, a liability to CHOKING whilst eating. This, no doubt, is an exaggeration of the difficulty in swallowing, which, as well as difficulty of speech, is so common a symptom in

which, as did her footsteps, repeated and kept up the same time as the respiration of the dying man. At last this state had to be checked and arrested by friends.

[1] Rostan (quoted by Aitken, in his 'Science and Practice of Medicine,' vol. ii, p. 340) mentions the case of a woman, aged 50, who had been the subject of chorea, affecting the entire left side since she was a child, in whom the limbs on the *same* side were *atrophied*. After death no morbid appearances were met with in the brain.

[2] Yonatt records the case of a dog with chorea, in which both pupils were much contracted.

[3] Dr. Fox of Clifton has told me of a case now under his care of an old lady in whom choreic movements of the right leg, hand, and arm, exist. They are most intense *during sleep*, but may be absent for a day together, and can almost always be controlled by a touch of any one's hand.

certain of the severer cases of the disease, or it may have been hysterical in its character.

Case 35 was remarkable, as exhibiting a tendency to RETENTION OF URINE, which sometimes lasted for twenty-four hours, Dr. Chambers, in his 'Lectures,' page 360, mentions the case of a boy, aged nine, with chorea, who was unable to retain his fæces or urine; and Trousseau alludes to cases of relaxation of the sphincters of the rectum and bladder. To the condition of the sphincters in chorea, I have already alluded in connection with one of the fatal cases described (see footnote, page 18). Dr. Levick, in his paper above quoted, states that Dr. Pepper, of the University of Pennsylvania, told him that he had known incontinence of urine to interchange with chorea of the external muscles and conversely.

In addition to the above cases of chorea, I have notes of one or two other remarkable cases, in which the symptoms were exceptional. Thus, three or four years ago, we had in our wards for a length of time a case of a lad aged eighteen, the son of a medical man, affected with a form of chorea in which, in addition to the more ordinary involuntary spasmodic movements, the most grotesque and at the same time alarming actions were exhibited, for he was constantly and violently throwing about and twisting his whole body and his head to and fro, and his arms in all directions, sometimes falling down as if dragged down by his own contortions; constantly "hanging himself" against the bedstead, and making his face quite turgid, and putting himself out of breath by his exertions and jactitations, making also a peculiar grunting noise; all this time being made worse whenever he was noticed or questioned about it. It was said that he had caused the affection by masturbating habits, and that he had been treated by caustics applied to the urethra.

He had been in St. Mary's Hospital, and most accidentally I found that it was the case described in Dr. Chambers' 'Lectures,' p. 378, as being under his notice in St. Mary's Hospital in 1860. The movements are well described as "coming on in paroxysms, principally affecting the muscles of the neck, and twisting his head so far round sometimes as to cause him to tumble down, screaming and barking." Among other remedies, morphia was tried subcutaneously injected at St. George's Hospital, and it was also tried, along with other things, at St. Mary's Hospital, but no good appeared to follow. He left London in much the same state as when he came, and eventually he was, as it turned out, placed under the care of my friend, Dr. Boyd, at the Wells Asylum, where I accidentally saw him several months afterwards, whilst on a visit at Wells. He was out in the garden, talking to himself among some bushes, and I was told that his habit was to be out much alone, which was permitted. He

recognised and was pleased to see me, and talked about St. George's Hospital. He was very much quieter than when I had seen him previously, though he still knocked about his head and body to a great extent. In a letter received from Dr. Boyd in December last, he says, with reference to him—"The young man with chorea, now aged twenty-four, is still here. He has not been under any course of medical treatment lately, but he still uses the cold douche himself or the shower-bath. He is rational, and in very good health, but still has spasms affecting the muscles of the face and neck principally; he stammers, and the spasms increase when spoken to, especially by strangers. During the summer he was able to join at cricket, also in the weekly dances, and he assist the attendants out of doors occasionally. He has always cared little for cold air, but heat oppressed him. He has a large appetite for food. He might now engage in some suitable occupation."

In the case of a young woman, with deformity of the fingers and toes, who was in our hospital with an hysterico-choreical attack about two years ago, and who often visits the wards now, the chief symptom consisted of spasm of the neck-muscles, a peculiar jerk of the head, accompanied by a remarkable squeaky noise formed in the larynx, reminding one of that made by a guinea-pig, as if the breath were suddenly and involuntarily propelled by some spasm of the expiratory muscles.[1] A similar jerking back of the head from chorea of the neck-muscles is related by Dr. Barker in the 'Medical Times and Gazette' for 1863, July 25th. No other muscles of the body were affected; the patient recovered. On the same page (92), a case of chorea under Dr. Brown-Séquard is recorded, in which GREAT HYPERTROPHY of the muscles of the neck was caused by their constant action. The above-mentioned peculiar sound or squeaking noise recalls to mind a remarkable case of chorea related by Dr. Thompson, of Bideford, in the 'British Medical Journal' for February 11, 1865, in which, along with a variety of other odd symptoms, the patient had "a peculiar convulsive voice-sound, somewhat resembling hiccough, repeated with almost the rapidity of time-seconds, and accompanied by an agitation of the neck much resembling paralysis agitans."

In another case, which was under my care as an out-patient at the

[1] Romberg, in vol. ii, p. 55 of his work (Sydenham edition), relates the case of a female, æt. 48, with chorea of eight years' standing, in whom "inspiration was often accelerated, and accompanied by a loud *whistling* sound;" also that of a child, æt. 8, in whom dyspnœa, *whistling* inspiration, and palpitation existed; and a third one, a child, in whom was observed a "rapid and short concussion of the thorax," "invariably accompanied by a brief snapping noise," the result of an affection of the inspiratory, specially intercostal muscles, and a spasmodic condition of the glottis. Trousseau speaks of the voice being altered in some cases of chorea, and the patients uttering "a kind of a bark," and also of the voice "coming out in inspiration, instead of expiration."

hospital, the patient (a woman) was constantly *rotating* the head as fast as she possibly could; the velocity of this movement was excessive, but it appeared to have no important effect upon the patient, whereas on trying myself to execute it with the same rapidity, I became quite giddy at once, and unable to proceed. The patient had been subject to the affection for some months, and never appeared at the hospital without this rotation of the head going on.[1] After a time I quite lost sight of this patient. In another case, apparently of chorea combined with hysteria, related lately to me by a non-medical friend, during the attacks the patient would rotate round her own axis with great quickness, somewhat reminding one of those singular and rare cases of disease and injuries of the different parts of the cerebrum proper, also of the pons Varolii, medulla oblongata, and cerebellum, or its peduncle,[2] in which rotatory movements are at times

[1] Flourens, in his 'Experiments on the Respective Independence of the Cerebral Functions,' related to the French Academy, April 1, 1861, found that section of the semicircular canals produced brusque motions of the head in various directions, according to the canal injured.

[2] It may be of interest here to refer a little to these rotatory motions. Authorities, chiefly French, as to the cause of such movements are mentioned by various writers of past years, but the reader will find more recent interesting observations, by Gratiolet and Leven, related to the French Academy, on rotations on the axis of the body, produced experimentally, recorded in the 'Archives Gén. de Méd.,' vol. i, 1861, p. 112. They found that vertical section in the centre of the lateral lobes caused the animal instantly to rotate, and when the rotatory movements were arrested for a time the least noise or movement produced their return. The observers came to the conclusion that in the uninjured animal all the muscular equilibriums were in accord and harmonious, whilst after lesion of the cerebellum there was a manifest dissociation of these equilibriums,—this where resides the sense of co-ordination of the movements of the body. In the effect constantly resulting from every lesion of the lateral parts of the organ 'Journal de Physiologie,' 1861, Wagner, in his observations on the functions of the brain, details the results especially of experiments on the cerebellum. In addition to other consequences he found that injuries on one side of the cerebellum produced movements of rotation sometimes on the side of the injury, at others on the opposite side; but these movements after a time disappeared. In the same journal is a note by Brown-Sequard on rotatory movements *apropos* of a case of "mouvement de manége" in a cat, the result of hæmorrhage into the pons Varolii, in which he suggests that rotatory movements are the result of convulsions localised in certain groups of muscles, and that some direct or indirect irritation is the cause of these convulsions. In the 'Comptes rendus,' 1860 and 1861, the results of observations, by Flourens and Czermak, on the peculiar movements of the head, caused by injury of the semicircular canals, will be seen. A highly interesting case of epilepsy in which unmeaning laughter, tetanoid spasm, and peculiar rotatory movements, chiefly from right to left, has been described by Dr. Paget, of Cambridge, in the 'British Medical Journal,' Sept. 22, 1860. In Dr. Brown-Séquard's 'Lectures on the Phys. and Path. of the Central Nervous System,' 1860, remarks exist (p. 192) about the production of these rotatory or vertiginous movements, which vary "according to the place injured and the depth and size of the injury," and are the result of spasm of certain muscles, or of anæmia or irritation of distant nerves,—injuries of the different parts of the optic thalamus, the crus cerebri, the tubercula quadrigemina, processus cerebelli, auditory and facial nerves, and the neighbourhood of insertion of the cervical roots of the par vagum, according to the experiments of himself, of Flourens, Schiff, Magendie, Lafargue, M. Magron, &c., being quoted. The various theories regarding such rotatory

manifested.[1] Trousseau, among other varieties of chorea, speaks of chorea rotatoria and chorea oscillatoria.

Similar cases are mentioned by Dr. T. Thompson, who alludes (op. cit.) to instances of involuntary movements of the whole or of parts of the body, and observes that rotation of the head had been noticed by Drs. Conolly and Crawford, and Mr. Hunter, and others; he especially quotes also a case of Dr. Watt's, in which a girl was wont to spin round on her feet like a spinning-top, or to roll rapidly in bed from one side to the other sixty times a minute. Dr. Winn, in the 'Med. Times and Gaz.,' 1855, records the case of a child who, being nine years old, had had from infancy constant rotatory movements of the body from left to right. Sometimes these movements are doubtless the results of habit. A child with dropsy and disease of the kidneys, under my care in the hospital lately, had clearly the habit (without any disease causing it) of rolling the head on the pillow constantly from side to side. Another child in the next bed, under the care of my colleague, Dr. Barclay, had this movement also, but in her case the patient was subject to remarkable epileptiform attacks, which could be at any moment excited by a sudden (unexpected or not) tap on or shake of the head or shoulder. Dr. Barclay will publish this interesting case, I believe, but allows me here to mention it.

Among these anomalous cases of chorea or chorea-like affections few are more singular, perhaps, than those which, consisting of bowing movements, have been termed "eclampsia nutans," and by the late Sir C. Clarke "salaam convulsions." Of this affection I have only seen one instance, and that was in a child whom I attended along with Dr. Marshall Hall, who has described this form of disease. In this, the patient, a child, was from time to time affected by a peculiar slow and measured to-and-fro motion of the entire body. Levick (op. cit.) speaks of this variety, and describes two cases of it which he had seen, one in a child, and another in an adult. He quotes several authors who have described or given cases of this singular affection.[2]

movements are also considered in connection with experiments upon the tadpole, by Velpeau, in the 'Gaz. Méd. de Paris,' 1862, No. 20. Friedberg, of Berlin, communicated to the Academy of Sciences the case of a patient who was trephined for fracture of the right parietal bone, and who subsequently became affected with diabetes, then the rotatory or "manége" movements in the longitudinal axis of the body, then hemiplegia on the right side, and then paralysis of the par vagum. He takes occasion to make several propositions regarding the conditions for the production of this rotatory movement. Meanet also, *dpropos* of a curious case, has a paper in the 'Archives Gén. de Méd.' for May, 1862, upon the so-called "circular" or gyratory, and the manége movements, which he likens to the staggers in sheep, except that they are not the result of the presence of cœnuri.

[1] This movement has been noticed in the chorea of dogs.

[2] West, Barton, Bird, Newham, Wiltshire, Faber. In the 'American Journal of Medical Science' for April, 1843, a case of "salaam convulsion" is related by Dr. Bennett. Dr. John Clarke informs me he has seen one case of this affection in a child with mesenteric disease: the movement of the head was from side to side, and existed hardly without intermission for three weeks. After death, congestion of the cerebral membranes and softening of the brain with effusion of serum in the spinal canal were found.

The following case of anomalous chorea was under my care some months ago:—

Emma F—, æt. 11, one of seven sisters, of whom all others were healthy, though the family was phthisical, was admitted into St. George's Hospital, October 4th, 1864, with chorea. She had been ill twelve months, and done no work all that time. Her illness was described as having begun with symptoms of cold and swelling of the knees, and when admitted there was some enlargement of the inner condyles of both tibiæ, and some œdema of the legs. The heart's sounds were natural. There was a little cough and pain in the head. The urine was phosphatic and turbid and contained a slight amount of albumen. The patient left the hospital on the 24th, in the same condition as when she came in; and it was said that she had a brother who died after an eighteen months' illness of the same disease, but without the St. Vitus's dance.

She was again admitted February 27th, 1867, under my care, but in a much worse state than when she left the hospital, having for five months QUITE LOST HER SPEECH. The catamenia had never appeared.

When admitted, it was found that she would lie in bed without changing her position, but having almost continual choreic movements over the whole body; when the movements ceased the limbs were rigid. She was quite unable to articulate, but understood all that was said to her. She was apparently suffering pain, and she was frequently putting her fingers into her mouth. The pupils were rather dilated, but equal in size, and acted well to light; no strabismus existed. There was complete paralysis of the sphincters of the rectum. The limbs were all, as before said, rigid, and when moved they would remain in *the same position in which they were placed*, and the head was generally drawn over to the left owing to spasm of the right sterno-cleido-mastoid muscle. The pulse was 160 per minute and the skin very perspiring and 99° F. of temperature. She had an oil and assafœtida enema, and scammony calomel, at the same time.

In the evening the temperature was 101 F.°, and on the following morning 99·8°. Large crepitation was found in both lungs, and two or three days later the left hand was spasmodically contracted, and she had been very noisy and delirious, requiring the subcutaneous injection of morphia, which was afterwards from time to time repeated. Quinine, and steel, and valerian, and stimulants, were given. About a week after admission, the pupil of the *left* eye was

found from time to time to be *smaller* than the other one, but not always so. The lungs continued loaded, but there was no dyspnœa.

The temperature continued very high, generally about 101·6°. Continual recumbency on the right hand had produced some soreness and vesication. It was observed that the extensor muscles of the right arm seemed partly paralysed, whilst those of the left arm and of the toes of the right foot were spasmodically contracted. She took strychnia subsequently, along with steel. She varied much both as to taking food and sleep, sometimes requiring the morphia injection; at times she was also much noisier than at others. The profuse perspirations were treated by opium and sulphuric acid, though not with much success. On the 11th of March, it was noticed that an abscess had formed at the left temple owing to the head being so much drawn to that side. At the end of March, it is reported that her appearance was improving, and that she continued to take food well. Both knees were drawn up to the abdomen constantly as before, the bed-sores looking better. Moist sounds existed extending in both lungs. The temperature was then generally 98·6°. The tincture of Cannabis Indica and shower-baths were prescribed. Throughout, the pupils were very dilated. About April 5th, she spoke a few words occasionally. The bed-sores continued to do well; the Cannabis was increased, and subcutaneous injections of morphia and atropine were given. On the 20th she went out having from time to time spoken a few words. I have heard nothing of her since.

The high temperature in the above case is of interest, though perhaps not so much so as if the case had been less complicated. No doubt it must be considered as resulting from the quickening of the heart and circulation, consequent upon the muscular activity. In many ordinary cases of chorea I have failed to meet with any positively increased temperature.[1]

In connection with this subject, as a result of muscular movements, I may here allude to the high *specific gravity* of the urine, and the amount of *urea* in that excretion spoken of by some as existing in cases of chorea. The reader will know that I allude to the observations of Walshe (see Lectures on Clinical Medicine, 'Lancet,' 1849, vol. i, p. 85), Bence Jones, Todd, and others. For myself, in a great many ordinary cases of chorea, I have been unable to find anything of the kind beyond what would doubtless be produced by the comparatively high feeding which chorea patients are subjected to. In many cases, even where much food was taken, the

[1] My friend Dr. Fox tells me that he has found the temperature in chorea to be "99·3° and 100°, and even rather more at night, and that was so in cases where there was not much muscular movement." He thinks it probable that temperature in chorea is higher in cases in which rheumatic element exists. Dr. Ringer has kindly lent me the records of the temperature of three patients with chorea, and in two of these the temperature was, for a short time, raised; but this elevation appeared to occur when the patients were suffering from rheumatism.

urine did not range above 1019 or 20°, but lithates were very abundant.

No doubt under the light of former physiological knowlege it was naturally expected that an increased excretion of urea would take place as an inevitable result of tissue metamorphosis in chorea. Present teaching, however, shows us that we ought neither to have found nor sought for such increase of urea in chorea. On this matter see the 'Ed. Med. Journal,' Feb. 1866, wherein Dr. K. Anderson describes the daily amount of urea in the second week of typhus, as being "decidedly below the standard of health, notwithstanding that the patients were in a state of high fever with the temperature and pulse much above the normal state." See also the experiments of Bischoff, and Voit, and Fick, and Wislicenus of Zurich, corroborated by Professor Frankland, from which it appears that muscular power is derived from the oxidation of hydro-carbonaceous material mainly, though not entirely. Frankland thinks the mechanical force of the muscles is derived from the oxidation of matters contained in the blood, and not from that of the muscles themselves. Dr. Parkes (see 'Proc. Royal Soc.,' Jan., 1867), from experiments, came to the conclusion that, unless nitrogen be found to disappear through the skin, it must be supposed that muscular force is derived from the carbo-hydrates, the amount of nitrogen excreted during active exercise being lower than that excreted during a period of rest, though in the period of rest following work, it is slightly increased. Pettenkofer and Voit noticed recently that muscular work seems to have no influence on the amount of urea excreted.

I will now add the details of a case which was not under my care, but of which I have been favoured with the following notice. I have alluded to it at foot-note to page 26.

It was that of a boy who lived in Derbyshire. He had had some kind of "fever" and was inefficiently nursed, and, subsequently, became severely affected by chorea; during sleep he was perfectly quiet, but on waking would at once commence singing and shouting vociferously, and jumping and "working about" as friends described it, until he was quite exhausted. He would jump violently, and scream loudly, and by jerking motions eject the spittle to an enormous distance. For some time he was unable to swallow any substance, and at last became in consequence "so frantic for food" that he swallowed everything whole directly he put it into his mouth. In this condition he continued for several weeks, and was treated by T. Fentem, Esq., of Eyam, who, in addition to other treatment, applied a blister at the back of the neck. At last, it was determined to take him to the Sheffield Infirmary. To the boy's delight (expecting cure at the Infirmary), a carriage was procured for him, and he was conveyed thither a distance of several miles. He jumped

about and was unmanageable in the vehicle for some time as usual, but when they arrived at the Infirmary with him it was ascertained that he was now all but well.[1] They kept him in the Infirmary for two weeks and treated him with tonics, good food, &c., and he left it still remaining quite well; and since then he has married, and has had no return of the affection. It was the conviction of himself and his friends that he was cured by the shaking of the carriage. This case somewhat reminds one of those cases analogous to chorea termed "epilepsia saltatoria."[2]

[1] I have previously (specially when referring to this fact as a reason against the supposition of serious injury to the nervous centres existing in such cases) alluded to the rapid removal of chorea which sometimes takes place. I may here quote the case of a girl, A. H—, who was admitted into St. George's Hospital with chorea, under the late Dr. Page's care, not long ago. She became the subject of scarlet fever, and the chorea almost entirely departed, apparently in consequence of this attack. I find in the 'British Medical Journal,' August 1st, 1863, p. 121, a case, quoted from the 'Gaz. des Hôp.,' of chorea cured, and permanently so by an attack of fever caught in the hospital. Dr. Painter, of Beaufort Gardens, has lately informed me of a case of aggravated hysterical paralysis, which was singularly cured in his presence by the "fright" produced by the sight of a leech on the ground. Many readers may remember the case of paralysis cured by Sir H. Davy, merely by the daily placing the thermometer under the tongue.

[2] The reader will find the details of a fatal case of chorea in a girl, æt. 13, related by Dr. Inman, of Liverpool, in his work on 'Neuralgia,' 1860, p. 249. The patient appears to have died of exhaustion; the choreic motions ceased some hours before death. "The post-mortem showed as healthy a body as it was possible to examine." This case is also related along with another fatal case, in which the symptoms "resembled those of tetanus and chorea, but were identical with neither," in his work the 'Foundation of a New Theory,' &c., p. 466. In Schmidt's 'Jahrbücher,' 1865, Bd. 137, ser. 2, p. 169, are quoted two cases of so-called "chorea magna," of which one proved fatal. This case had been under the care of E. Vecchietti, in the Ospedale Maggiore at Bologna, and was that of a boy, aged 13, who had had acute rheumatism. The choreic movements commenced in the right arm, and then extended to the entire body. Among other symptoms pressure on the vertebral column was painful. The *temperature was increased*, and the skin greatly perspiring. After death, in addition to other appearances, the veins of the vertebral canal were found distended with blood, the cellular tissue injected, especially about the first dorsal vertebra; and the veins and capillary vessels of the cerebral membranes were injected. The spinal cord opposite the first dorsal vertebra was greatly softened, and of a reddish colour. The *other* case of "chorea magna" did not prove fatal, and was communicated by Dr. Frangue of Munich. The patient was a boy 11 years old, who after a fright from a blow on the shoulder lost his speech for six weeks. Speech returned afterwards for a single day, and then disappeared again, choreic movements coming on. Speech again returned, but the choreic movements became worse, and eventually of a most violent kind. With intervals of intermission the disease continued above two years. Much urate of ammonia was passed, and on two examinations abundance of SUGAR was found in the urine. Frangue says that in a female choreic patient he had found sugar in the urine which was not there before, or in the intervals, after every attack. Other cases of so-called "magna chorea" are on record, chiefly in German literature, and it seems to bear the name with some authors of "Chorea Germanorum." As far as I can learn, Skoda first used the name chorea magna, which he described ('Allg. Wien. Med. Zeitung,' 1858, 36) as being distinguished from so-called "chorea minor" only by its paroxysm-like invasion: the movements may be, however, of a springing, revolving character, and generally are very violent, but not trembling, as in paralysis agitans. Among such instances of chorea magna, two cases are particularly interesting, one described by Mossler, of Giessen ('Deutsche Klinik,' 1860, p. 30) in a girl aged 12, apparently connected with menstrual efforts, and ending in hysterical convulsions; and another, described by Roth, of Bamberg (see 'Jahrbüch,' vol. cxix, p. 294), in a child aged 11, who became insane and epileptic.

In bringing to a close these observations upon chorea, I will (in reference to the questions connected with the history of the fatal cases which I have already given) add the notes of yet other *fatal* cases,[1] two of which have not been yet placed on record. Of these, that already published by Dr. Day, in his 'Clinical Histories with Comments' (see p. 101), is so interesting that I may be pardoned giving a brief abstract of it. The case was that of a boy, aged nine years, who had had acute rheumatic fever two years previously (? with any heart mischief), and who experienced a second attack. Four days after the commencement of the second attack chorea set in. Pericarditis came on, and he died eventually completely exhausted, retaining consciousness to the last. It was remarkable that the choreic spasms were not arrested (only lessened) during sleep; and also that the acid perspirations were confined to different parts of the body at a time, sometimes to one side only, or to a particular limb. After death, in addition to old-standing valvular roughnesses, the fleshy columns and tendinous chords of the heart were covered with "*lymph-like exudations*." The brain was healthy, but the vessels of the spinal membranes were very distended with blood, and in some cases had given way. The spinal nerves over a large extent of the chord, where emerging from the intervertebral notches, seemed pinched, their membranous covering being "at least four times as thick as it normally should be, so that it appeared to form a complete stricture, whilst both before and behind this constriction there was ample evidence of inflammatory action." Moreover, large discoloured spots were found under the skin of the body in many parts. Dr. Day alludes to Dr. Stiebel's opinions (see 'Wochenschrift f. d. Gesamm. Heilk,' 1837, No. 1.; also, 'Brit. and For. Med.-Chir. Rev.,' Oct. 1837, p. 504), that chorea was entirely occasioned by spinal-nerve-irritation, the result of turgescence of the membranes of the spinal cord or medulla oblon-

[1] Dr. Fox, of Clifton, has quite recently sent me the note of the following case of complicated chorea. It was "that of a girl who had been epileptic for some years. In spite of this she went to school, and was much impressed by the sayings and doings of a curate with Revivalist tendencies. She was brought to the infirmary with violent choreic and jactitations of the sides, and spent several days and nights in screaming, praying, and swearing. She considered me an impersonation of Satan, and on one occasion bit me severely. In fact, she resembled some of the worst cases of Revivalist hysterical mania, with the element of chorea superadded. In a few days she became more calm, and the chorea gradually left her, but, against my orders, the curate was allowed to see her during her convalescence, and a recurrence of all her symptoms, choreic and other, was induced. She recovered entirely after a complete separation from the religious exciting cause. She died some years afterwards of fever, having been convulsed almost without interruption for forty-eight hours before death, and no lesion of the spinal cord or brain was detected."

gata, and that possibly such other causes as "injuries to the spine and metastasis of rheumatic inflammation" may exist, which causes would of course produce the above-named spinal-nerve-irritation. He, however, unlike Dr. Stiebel, denies that all cases of chorea are dependent on one universal and unalterable cause, and suggests "that in the milder and more yielding forms of the affection, there is mere functional disturbance," while in the "graver attacks there is ALWAYS going on a local lesion of a severe character." Dr. Day observes that in the milder cases the movements were rather like exaggerated natural motions with a shade of "CONTROLLABILITY," whilst in the severe forms "all control is evidently gone, and the spasmodic affection seems to partake almost of the nature of tetanus."

Dr. Day adverts also to the suggestion of Dr. Stiebel, that in the milder cases of chorea, which generally occur amongst young growing persons, it is probable that, as the spinal marrow and the origin of its nerves lie within a bony canal, there may be during development "some want of due relation between the bones and the enclosed part of the nervous system, the cavity not corresponding to the increasing marrow, and then a constriction or pressure may for a time produce an irritating effect." I need hardly say that such an anatomical cause would hardly be consistent with the changing and transitory character, and the rapid curability or removal of the affection in many cases. Dr. Stiebel remarks that of the nearly one hundred cases of chorea which he had seen, in not one was there wanting the evidence of an irritation of the spinal nerves, few of the patients not having had pain in some one of the vertebræ during the course of the disease. I have myself frequently noticed that pain was produced in choreic cases by pressure of certain parts of the spine; but I would suggest that such pain need not of necessity indicate any irritation of spinal nerves; it might have been rheumatic, and connected with the fibrous structures about the vertebræ. In connection with this symptom a case related by Dr. Marshall and quoted by Dr. T. Thompson (op. cit.) is interesting, in which symptoms resembling chorea were apparently produced by lightning, and these symptoms were much aggravated by pressure at certain points of the spine. Dr. Day, in alluding to the discoloured spots under the skin in his fatal case, takes occasion to comment on the connection established by some authors between "nerve lesions" and certain eruptions and morbid appearances of the skin. I will here refer to the mention made by Dr. T. Thompson (loc. cit.) of cutaneous diseases, such as urticaria and roseola, co-existing along with chorea and probably resulting from the same state of the nervous system. He quotes one case of chorea of a remarkable kind, in which diffused patches of a bright-red eruption came out near the elbows, on the day the motion ceased, and lasted three days. It came on afterwards again on the arms, when the eruption recurred. I find that Dr.

Bright noticed the coincidence of roseola with chorea (loc. cit. p. 489).

Dr. Day has obligingly lately sent me the notes of the following case which proved fatal.

"A young woman, in the third month of pregnancy, was admitted into the (Stafford) infirmary, suffering from occasional attacks of chorea. The involuntary movement of the voluntary muscles were strange and grotesque, but at first not violent; they soon, however, became so, and so uncontrollable, that she was placed in a ward by herself, all the furniture being removed and the floor being covered with bedding to prevent her injuring herself. No treatment seemed to benefit her, and I was requested to see her a few days before she died. I suggested that the uterus should be emptied; this was not assented to. I had ice bags applied to the spine (there was considerable spinal tenderness) but this did not make matters any better. I then succeeded in bringing her under the influence of chloroform, and she got some rest and *disturbed* sleep; upon waking, the movements commenced as violently as before. She obtained rest and sleep every now and then from the chloroform, but at last died thoroughly exhausted, retaining her consciousness to the last. Post-mortem examination disclosed everything natural except the membranes of the spinal cord, which showed evidence of intense inflammation."

The third and last additional fatal case of which I spoke was as follows. It quite recently occurred at the Somersetshire Asylum, and for its particulars I have to thank my friend Dr. Boyd.

C. C—, æt. 23, married, was six months pregnant with her second child. She was the subject of most severe spasmodic action of the limbs and neck; the cheeks were reddened from friction caused by jerking of the face against the bedding. She was able to answer questions but with great efforts. The tongue was moist and white. The pulse could not properly be counted owing to the jerking of her arms. Bowels confined; the swallowing of food was difficult. She was labouring also under severe bronchitis and her breathing was difficult. The œdema had existed three weeks when premature labour occurred, the fœtus having apparently been dead two or three days; on the following morning she died. She had sleep from an opiate the night before her death, but for several nights previously had had no sleep.

After death the brain, which weighed forty-four ounces, was found congested but natural in structure. The spinal cord was soft and pulpy throughout its entire length. It was examined for me by Mr. Lockhart Clarke, who has sent me the following notes of the specimen: "The spinal cord was slit through longitudinally; only the lower part of the lumbar enlargement remained entire, and this was

not sufficiently hardened to admit of making thin sections. The lower portion of the dorsal region which had been slit through was evidently softened; small fragments examined under the microscope exhibited, however, chiefly an admixture of granules, with some compound granular corpuscles, without any remarkable alteration in the condition of the nerve-fibres. This condition resulted no doubt from an early stage of softening in which a granular fluid exudation was poured out. Just below the middle of the lumbar enlargement the tissue was perfectly pulpy—of the consistence of cream; and a small portion of this picked out and placed on a slide with as little disturbance as possible, showed under the microscope scarcely anything but broken nerve-fibres mixed with granules and some compound granular corpuscles. Almost every fibre had assumed the form of the well-known globular or oval masses of myalin or white substance, of different sizes; so that under a low power the arrangement resembled the cellular structure in a section of wood or stem of plant. In the lower part of the lumbar enlargement that had not been slit the grey substance was evidently in a state of disintegration." The lining membrane of the bronchial tubes was red and coated with reddish mucus. The abdominal organs were healthy.

Thinking it might be interesting to search out what might have been the number of deaths from chorea returned and registered, as having occurred in England and Wales during a series of years, I found that from the year 1839, the first year of our present national plan of registration, they were as follows:

	Deaths from Chorea.		Deaths from Chorea.		Deaths from Chorea.
1839	54	1851	77	1859	55
1840	25	1852	73	1860	66
1841	28	1853	67	1861	71
1842	19	1854	48	1862	52
1847	39	1855	69	1863	63
1848	38	1856	59	1864	73
1849	34	1857	44	1865	88
1850	60	1858	53		

The number of deaths in the various years is very unequal; it would be interesting to try and find out if this difference could fairly be attributable to any peculiar atmospheric or climatic cause. Many authors (this is mentioned by Bond) have found chorea to prevail much more in cold weather and winter than in summer, and certain observers practising in tropical climates have never met with it there. Others again, as quoted by Dr. T. Thompson (op. cit.), consider it to be more common in summer.

Corrigenda.—At page 23, in the third line from the bottom, in the place of "the exit of," *read* "altering"; and in the line below, *read* "are," in place of "being." Also, at page 27, in the second line from the top, in place of "and universally *uninterrupted*," *read* "and almost universally *uninterrupted*."

Professor Parkes, with the author's Compliments Oct. 1867

POLITICAL ECONOMY

OF

BRITISH WESTERN AFRICA;

WITH THE

REQUIREMENTS

OF THE SEVERAL COLONIES AND SETTLEMENTS.

(THE AFRICAN VIEW OF THE NEGRO'S PLACE IN NATURE.)

BEING AN

ADDRESS TO THE AFRICAN-AID SOCIETY.

BY

JAMES AFRICANUS B. HORTON,

M.D. EDIN.;

STAFF ASSISTANT-SURGEON OF H.M. FORCES IN WEST AFRICA; ASSOCIATE OF KING'S COLLEGE, LONDON; FOREIGN FELLOW OF THE BOTANICAL SOCIETY OF EDINBURGH; CORRESPONDING MEMBER OF THE MEDICAL SOCIETY OF KING'S COLLEGE, LONDON; FELLOW OF THE NORTH SOCIETY OF EDINBURGH, &c., &c.

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LONDON: W. J. JOHNSON, PRINTER, 121, FLEET STREET.

TO

LORD ALFRED SPENCER CHURCHILL,

CHAIRMAN OF THE AFRICAN-AID SOCIETY, VICE-PRESIDENT OF THE INSTITUT D'AFRIQUE, &C., &C.,

These Pages

ARE MOST RESPECTFULLY DEDICATED,

BY

HIS MOST OBLIGED AND HUMBLE SERVANT,

THE AUTHOR.

TO F. FITZGERALD, ESQ.,

SECRETARY OF THE AFRICAN-AID SOCIETY.

MY DEAR SIR,—Whilst economists and politicians, statesmen and philanthropists, are endeavouring to point out the Christian wants and political requirements of the natives of British West Africa, it will not be surprising to you should I now forward what, in the opinion of an African, are the chief political wants of this Coast, in conformity with the wish expressed by you in your letter to me, dated the 23rd July, 1864.

For the last six years I have made it one of my duties to study how the interest of the colonies, together with their material advancement, might be best promoted with as little expense as possible to the Home Government; and in availing myself of this opportunity of forwarding my conclusions in the form of an Address to the African-Aid Society, I must confess to a certain misgiving as to whether what I have stated about the political economy and requirements of British Western Africa does not fall short of what might be conceded with advantage to these countries and their peoples. I cannot help feeling a certain embarrassment in asking you to bring the contents of these pages before that Society, when I find that I am addressing those to whose wisdom and experience in political matters I have been accustomed to look up; but I feel re-assured by the consideration that, as the most accomplished audience is ever the most indulgent, they would detect and give the full value to every important suggestion which they may observe in the Address.

Lord Alfred Churchill, in a letter to the editor of the *African Times*, published in the August number, has advised the people of Africa to consider themselves as having the right, in common with other British subjects, to petition either directly to the House of Commons, or by memorial to Her Majesty, whose ears will never be closed to their just and reasonable prayer, whether the colour of their skin be what it may. The African-Aid Society and their journal have given the people of Africa great political liberty; they have made them to feel the power and capacity of action and forbearance, the non-existence of any obstacle that their will cannot overcome when they have the desire to act, as well as the entire absence of any superior power that would compel them silently to

suffer what is unjust when they feel a desire to proclaim their wrongs.

It will be necessary for the Government to be very circumspect in the selection of her officials for the Coast; and that the Governor-General, in particular, should be a man who possesses a happy tact and natural sagacity combined with experience, so as to hit the right course, since to him will be given the ground-plan of the future political Government; he should make it his first object to discover those salutary measures which are necessary, and endeavour to counteract those noxious influences which may sap the healthy action of the community; he must make himself perfectly acquainted with the internal affairs of each colony—its revenue and expenses, its commerce and agriculture—with the national character of the inhabitants of each section of the Government; he should form a correct judgment of the character of every prominent official in his Government; and he should possess a talent for comprehensive and rapid observations in the selection of fit instruments for different appointments.

It must be stated that in no part of the British colony on the Coast is the prejudice of colour so much exhibited as at present at Sierra Leone The existence of clanship is there carried to a fearful extent. During the Government of Colonel Stephen John Hill, he endeavoured, with no mean success, to break down that clanship which existed amongst the natives, and about which the Europeans complained so bitterly, and before he left there was an agreeable unity between all classes. *O si sic omnes!!* But at present there is a strong clanship amonst the Europeans, which is sanctioned and encouraged, and which has a most pernicious effect on the social wellbeing of the colony. The Governor-General should therefore be easily accessible to the prayers of all Her Majesty's subjects, and be ready to extend the same privileges to the educated natives which he gives to the educated Europeans, endeavouring to break down that prejudice of colour which, unhappily, is predominant at the seat of his Government.

I am, my dear Sir, your obedient servant,

AFRICANUS HORTON.

Bathurst, River Gambia, August, 1865.

POLITICAL ECONOMY OF WESTERN AFRICA.

THE hypothesis based on the ingenious demonstrative analogies of the manners, customs, and tenets of the inhabitants at present occupying this globe, as compared with those a few centuries ago, may be safely regarded as a truism—viz., that mankind by the knowledge of metallurgy and other useful arts emerge from a primitive state of barbarism, and have gradually brought to themselves the benefits of a civilised life. Of this primitive state or mythic epoch but little is furnished us in history, and very little is actually known; but from analogical references we are led to believe the speculative traditions of the ancient Romans,* that "mankind, as the state of political community now exists, advance from a rude and helpless state to the formation of political society;" and entirely disapprove of the Greek mythological legend, that "mankind emerge from a state of innocence and bliss."†

Bearing in mind the foregoing, it will be my province to prove the capability of the African for possessing a real political Government and national independence, and that a more stable and efficient Government might yet be formed in Western Africa, under the supervision of a civilised nation, in conformity with the present Resolution of the Committee of the House of Commons.

In viewing the map of West Africa, and tracing out those political communities which are not due to the agency of more civilised politicians, we affirm that there are amongst them fixed and established Governments, although rude and barbarous; that the obedience to the supreme power in many cases is implicit, the right of property is enforced by adjudicature; and, although the power of the supreme head has been used with extreme despotism, as in Dahomey and Ashantee, yet still it is as true a political Government as that of France or England. By nature the African is a social being, possessing the capacity of commanding and obeying, and that type of improvement which advances as the reason is cultivated, which are the essential elements both of a political Government and a political community; and therefore they bear no relation whatever to those gregarious species of animals—apes, monkeys, &c. — to which some fantastic writers have likened them.

* Æschylus, Prom. 451—515; Diod. i. 8; Lucian, Amore, c. 33, 34.
† Hesiod, Op. et Di. 109; Ovid, Met. i. 88—112.

Examining Western Africa in its entirety, we find it to be composed of a number of political communities, each ruled by a national Government, formed in many cases of distinct nationalities occupying determined territory; but some national communities are broken up into innumerable fractional sections, governed by rebel chiefs, or satraps; others depend upon a political body whose sovereign chief rules over life and property; and others, again, are under well-regulated civilised government. But in order to develop among these different nationalities a true political science, it is necessary that the inhabitants should be made acquainted with the useful arts, and the physical conditions which influence other more civilised and refined political Governments.

What, it may be asked, are the different forms of government now in existence on the West Coast of Africa? The two principal forms are the monarchical and the republican.

In the purely native community we observe the recognition of power, vested in a single individual, variously called by the different tribes, but to which we apply the name of *basileus*, or king; surrounded by a number of headmen, who pledge themselves to do his will. Some of these *basileus*, such as those of Ashantee and Dahomey, have implicit power over life and property, and therefore are held in dread by their subjects. Of the tribes who are governed by these autocrats we may well apply the language of Merivale,* when speaking of the Asiatic races, that "they acquiesced in their own immemorial despotisms to which they have been abandoned. To them the names of liberty and equality, invoked in turn by their neighbours, are unintelligible; their sympathies are centred always in men, and not in government. A desperate and successful warrior commanded all their devotions, and for them the foundation of laws lay in the bosom of the autocrat.

"Not being acquainted with letters, they have no history; successive events once out of sight are for ever lost; they pass away like the spectres in a phantasmagoria, leaving no other trace behind them than a dreamy recollection of some distant circumstances that had taken place. They satisfy the curiosity of their generation by the oral narration of legendary tales, heroic myths, &c., descriptive of deeds of wonders at an uncertain and undated antiquity, and which forms the only channel by which their thoughts can be transmitted from one country and one age to another. Not knowing anything of the useful arts, their Governments are feeble and unenterprising, and their military organization impotent and inefficient; amongst the higher classes in some of them the head wives occupy important positions in the domestic circle, whilst all the other women occupy a degraded position.

"Proper legislative science is entirely unknown to them; they possess no means by which a continuous and profitable revenue can be brought into their imperial coffers; no proper determination of political causes, and, consequently, no established principle which might be made to form a guide to the Legislature in the making of new laws or the alteration of old ones, and thus for ages they have shown no improvement in the executive administration; and possess no proper legal status, and no generalised principle of international law. There is an entire absence of any domestic history amongst them; by them a society is never contemplated, either in its constituent elements or mutual relations; in its private recesses or habitual intercourses. A fact, an anecdote, a speech, or remark, which would illustrate the condition of the common people, or of any rank subordinate to the highest, is considered too insignificant to be suffered to intrude upon a relation which concerns only grandees and ministers, thrones and imperial powers. Some towns there are which are governed entirely by chiefs, who exercise uncertain rule over the inhabitants—who are regarded more as a father of the community than a political head; they are not nomadic in their nature, but constitute themselves into a political society of the most primitive style."

* History of the Romans under the Empire, Vol. ii. p. 141.

In the Colonies the monarchial form of Government in substance is observed; the different political heads are English, French, Dutch, and Spanish. The French occupy Senegal, Grand Bassa, and the Gaboons; the Dutch, a portion of the Fantee Territory; and the Spanish, Fernando Po. It is not my intention here to touch on the political bearings of these several Governments on the Coast, except that in whose interest we are principally concerned—viz., the English, who occupy the Gambia, Sierra Leone, Cape Coast (or the greater part of the Gold Coast), and Lagos.

The republican form of Government is that found in the Liberian State; under the auspices of the Colonization Society of America, a colony of American negroes was formed, which was ruled according to the American Constitution. The subjects having proved their capacity for self-government, powers were vested in their hands, and they formed themselves into a Republic.

The Liberian Government had its trials to encounter, but they have proved that they are perfectly competent to carry on their own Government; and having mastered a great many of the vicissitudes and drawbacks which a Government brought to existence in the form in which they have been brought must expect to meet with, they bid fair to occupy an important place in regenerated Africa.

But it was necessary that they should have made limited scientific experiments on the subject-matter of many branches of their political science, not for the purpose of determining abstract truth, but of establishing every portion of their executive administration on a firm and healthy footing. Being a new political assembly, when once they have chosen the subject of their experimentation, they should gradually examine and note the true relation of each phenomenon as it presents itself, their true political

causation, and what influence, ordinary and extraordinary, it has on the body politic of the nation; for when once a practical mistake has been made which acts extensively on the institutions and affects their political economy, it acts like an "electric affinity with the rotten parts of the social fabric, and dissolves them by combination."

Thus the Liberian statesmen have not long ago fallen into a grave error in the practical experiment which they made in their financial department. The materials employed were sound and valuable, but they were not used with that due correction and allowances which are essential for material success. They issued out during one of their political crises a certain limited amount of paper currency which was easily redeemable by the Government. The political success of this provisional experiment operated so greatly on their better judgment that, instead of acting like the pilot steering a vessel through an unknown and dangerous channel, the Executive launched out an excessive number of this medium—the greenbacks become at a very great discount—the strength of the Government is tried—it finds itself incapable of supporting the crisis; it now becomes its weakest point, and like the mechanical aphorism, nothing is stronger than its weakest point, so they find that no effect of theirs is capable of preventing a crisis:—

Multa quæ nunc ex intervallo non apparent bellum aperiet.*

The merchants receive the notes from the people at a fearful discount, and then pay them to the Government for duty and taxes at their full nominal value; the specie is exported to foreign countries, none is to be found in the State exchequer; and all Government *employés* are paid in greenbacks.

The British portion of the Government of Western Africa is in a transition state, and it is Mr. Cardwell, Her Majesty's Principal Secretary of State for the Colonies, to whom we must now look as the guardian of the practical policy of the Colonies of Western Africa in its internal and foreign relations; and now that he has carried us through the distress, danger, difficulty, and doubts attendant on the late Parliamentary Committee,† every African who deserves to have his nationality based upon a stable footing, must regard him as the statesman, whom we might liken to the steersman at the helm of a ship, who, by his attentive and vigilant observations, will guide the national policy to a successful end, and we hope that before his term of office is expired he will see

* Livy, xxviii., 44.

† Select Committee of the House of Commons on Africa (Western Coast), nominated March 3, 1865: The Right Hon. E. Cardwell, Secretary of State for the Colonies; Mr. Chichester Fortescue, Under Secretary of State for the Colonies; Sir Francis Baring; Lord Stanley; Mr. Seymour Fitzgerald; Sir John Hay; Mr. Charles Buxton; Mr. W. E. Forster; Mr. Gregory; Mr. Cheetham; Mr. Cave; Mr. C. B. Adderley; with power to send for persons, papers, and records. Five to the quorum. Members subsequently added to the Committee: The Marquis of Hartington, Mr. Henry Seymour.—*African Times*, Vol. iv., p. 114.

erected on the foundation he may have laid down a superstructure worthy of the name of a Liberal Government.

The new laws and measures which the Government, according to the resolutions of their Committee,* are now about to enact, giving to the educated natives experience in the form of government, will be a most important step in the advance of African history, and must be regarded for the present as provisional and tentative experiments until confirmed by proofs of practical success. It will be the place of the executive authorities to watch carefully and cautiously its operation, reporting faithfully on its progress, so that correct data may be drawn from it, just as the report furnished to the American Colonization Society, which subsequently led to the investment of authority on the inhabitants, thus virtually giving them a nationality.

In order that these propositions may be operative and effective, it is necessary that a proper executive machinery should be provided to give that impulse to native industry—to encourage that habit of independence and business—to excite that interest amongst the inhabitants of each locality for public affairs and political education, which the are intentions of the majority of the members of the late Committee.

Those who have gone to such extremes in opposition to the views entertained by Mr. Cardwell,† and our worthy supporter,

* *Resolutions of the House of Commons Committee on Western Africa*:—

1. That it is not possible to withdraw the British Government wholly or immediately from any settlements or engagements on the West African Coast.

2. That the settlement on the Gambia may be reduced by M'Carthy's Island, which is 150 miles up the river, being no longer occupied; and that the settlement should be confined as much as possible to the mouth of the river.

3. That all further extension of territory, or assumption of government, or new treaties offering any protection to the native tribes, would be inexpedient; and that the object of our policy should be to encourage in the natives the exercise of those qualities which may render it possible for us more and more to transfer to them the administration of all the Governments, with a view to our ultimate withdrawal from all, except, probably, Sierra Leone.

4. That this policy of non-extension admits of no exceptions as regards new settlements, but cannot amount to an absolute prohibition of measures which, in peculiar cases, may be necessary for the more efficient and economical administration of the settlements we already possess.

5. That the reasons for the separation of West African Governments in 1842 having ceased to exist, it is desirable that a central Government over all the four settlements should be established at Sierra Leone, with steam communication with each Lieutenant Government.

6. That the evidence leads to the hope that such a central control may be established, with considerable retrenchment of expenditure, and, at the same time, with a general increase of efficiency.

7. That in the newly-acquired territory of Lagos, the native practice of domestic slavery exists still to a certain degree, although it is at variance with British law; and that it appears to the Committee that this state of things, surrounded as it is by so many local difficulties, demands the serious attention of the local Government, with a view to its termination as soon as possible.—*African Times*, Vol. v., p. 6.

† Speech in the House of Commons, Tuesday, February 21, 1865.

Lord Alfred Churchill,* and many others, as to run down the capacity of the African race, and liken them to the anthropoid apes, ought to know that the African, in common with the most enlightened people, may be animated with feelings of philosophical speculations; and this is proved in the existence of a written language amongst them, designed entirely by themselves. The origin of this idea, if their mythological legend is reliable, was from the wonder excited by some messengers of the Quiah tribe, carrying a letter from an educated person of a more civilised nation to an individual at a distance, the reading of which conveyed to him the information of what had taken place in their own town. Possessing clearly a philosophical turn of mind, they became curious to discover the contrivance which so struck their observation, and from that time began to put in writing on leaves and barks of trees the language of their country.

Under the above considerations it is necessary that we should premise that the framers of the ordinance regulating the form of Government should not expect to meet perfection in the working of their plans; since it is a well-known fact that no Government can be copied from a plan. Our Legislature, therefore, must receive with caution the report of the ill-disposed, who will herald any seeming failure in their scheme, and should reply to them in the words of Lord Holland: "Attempts to form a perfect constitution have uniformly failed, and those institutions have thriven best which have sprung out of the necessity of the occasion. Constitutions are, in fact, productions that can neither be created nor transplanted; they are the growth of time, not the invention of ingenuity; and to frame a complete system of government depending on habits of reference and experience, is an attempt as absurd as to build a tree or manufacture an opinion.

"The chief objection to a constitution complete in all its parts is, that in the course of the last twenty years the experiment has been tried under various circumstances, and among different people, and that in no one instance can it be said to have succeeded. A constitution so drawn raises expectations which are not easily realised, and the disappointment produces either indifference to all law, or, on the contrary, a fresh endeavour, by the exaggeration of every principle of liberty and the subversion of every practical provision in the Constitution, to attain an ideal perfection, of which, perhaps, no human society is capable. Securities are devised against dangers which never exist, and inconveniences are soon felt which were not foreseen, and which no means are left for providing against. These difficulties must be submitted to, or, if removed, the alteration shakes the confidence of the public in the stabilities of law, the fundamental nature of which has been represented to them as their only security."†

It cannot be denied by even the most casual observer, that the British portion of Western Africa has made a very rapid stride in

* Speech in the House of Commons, Tuesday, February 21, 1865.
† "Sketch of a Constitution for the Kingdom of Naples," 1815.

improvement since Sierre Leone has been formed. Fancy a lot of slaves—unlettered, rude, naked, possessing no knowledge of the useful arts—to be thrown into a wild country, to cut down the woods and build towns; fancy these ragged, wild natives under British, and, consequently, civilised influences, after a lapse of a few years, to become large landowners—to possess large mercantile establishments and money—to claim a voice in the legislative government, and to give their offspring proper English and foreign education; and dare you tell me that the African is not susceptible of improvement of the highest order, that he does not possess in himself a principle of progression and a desire of perfection far surpassing many existing nations—since it cannot be shown in the world's history any nation with so limited advantage that has shown such results within fifty years. But we find that Captain Burton* and many others,† have unblushingly advanced the *theoreticum absurdum*, the jejune and barren generalisation or apophthegm, that British civilisation and Christian influences have demoralised the native African—that, in fact, these institutions were the chimera of a mistaken philanthropy; whilst the very advance of the African is a positive proof that they make it their principle that their great and leading object should be to "illustrate the provision made by nature in the principles of the human mind and in the circumstances of man's external situation, for a gradual and progressive augmentation in the means of national wealth; to demonstrate that the most effectual plan for advancing a people to greatness is to maintain that order of things which nature has pointed out," by encouraging the development of the useful arts, of agriculture, of education in the masses, which will be produced by the governed having a voice in the governing body, and which will lay in the minds of the rising generation a solid foundation of the fundamental principles of political government.

I claim the existence of the attribute of a common humanity in the African or negro race: that there exist no radical distinctions between him and his more civilised *confrère*; that the amount of moral and intellectual endowments exhibited by him, as originally conferred by nature, is the same, or nearly so, as that found amongst the European nations; and it is an incontrovertible logical maxim that the difference arises entirely from the influences of external circumstances. Truly—

Natura una et communis omnium est.

This dictum has been the theme of many writers in many ages. Sir William Temple,‡ in his essay upon the "Origin and Nature of Government," thus expresses himself: "The nature of man seems to be the same in all times and places, but varied like their statures, complexion, and features, by the force and influence of the several climates where they are born and bred, which produce in them, by

* "Wanderings in West Africa," p. 267.
† Lord Stanley, Speech in the House of Commons, Tuesday, Feb. 21, 1865. Dr. Hunt "On the Negro's Place in Nature," p. 57.
‡ Works, Vol. ii., p. 29, ed. 8vo.

a different mixture of the humours and operations of the air, a different and unequal course of imaginations and passions, and consequently of discourses and actions."

Aristotle propounded the same idea in his Rhetoric* :—

Ομοιοι γὰρ ὡς ἐπι το πολυ τὰ μέλλοντα τοῖς γεγονόσι.

I might adduce a great many examples to prove that the natural tendency of the now civilised Europe was exactly the same as the natural tendency of the now uncivilised Africa ; but I shall here only give a simple proof to show that they are not dissimilar to that of the ancient inhabitants of Britain. The inhabitants of the Gold Coast and other parts, to this day, paint their bodies with exquisite taste and beauty, although it is now gradually falling into disuse. History informs us that these were the wants and desires of the first inhabitants of England, and Dr. Johnson, in his "Life of Sir F. Drake,"† has said: "It is observable that most nations amongst whom the use of clothes is unknown paint their bodies. Such was the practice of the first inhabitants of our own country. From this custom did our earliest enemies, the Picts, owe their denomination. As it is not probable that caprice or fancy should be uniform, there must be doubtless some reasons for a practice so general, and prevailing in distant parts of the world which have no communication with each other."

To prove that right-minded men in England are alive to this truth, I need only quote the words of Lord Alfred Churchill‡ at the late meeting of the Aborigines' Protection Society : "I think it right to state, from having paid some little attention to the West Coast of Africa, and being on the Committee of the House of Commons for investigating affairs there, that I believe, from what I have heard, that the negroes on the West Coast only require a fair chance, when it would be found that their intellect and their capacity for self-government would be developed in a manner which at present we have little idea of. I believe there is nothing in their physical development, or in the formation of their brain, which would in any way incapacitate them from holding the highest position which civilised beings can aspire to. It is quite possible that it may take some time—some generations, perhaps—before this can be effected ; but by Christianising them, and giving them instructions in industrial pursuits, I believe it will only require some two or three generations to make them, under favourable circumstances, equal to Europeans."

The late Sir George Cornewall Lewis, in his "Treatise on Politics," has laid down the general aphorism, which might be well appropriated to the forthcoming measures of the Government—viz., that when the average and predominant operation of a political form or institution is good, it may be frustated by the badness of those who use it. We hope, therefore, that we shall not have to liken the persons on whom the execution of the scheme of the

* Rhet. ii., 20 sec. 88.
† "Life of Sir Francis Drake." Works, Vol. vi., p. 347.
‡ *African Times*, Vol. v., No. 49, p. 9.

Government depends to the tools of a refined maker placed in the hands of a clumsy or ignorant artisan ; since they may, from their moral defects, convert wholesome food into poison through the want of skill, intelligence, patience, and habits of sustained attention and mutual forbearance.

The tyro of African advancement will not look to them as the cause of the failure, but will entirely throw aside the legal maxim—

Quilibet præsumitur bonus, donec probetur contrarium—

and lay the whole blame, unheard, on the incapacity of the African race to support such a Government.

It cannot be expected that this legislative improvement will meet with disinterested preference from all the different Governments on the Coast. It might produce displeasure amongst those who from 1842 had independent actions, which has become a time-honoured custom to them ; and we do not blame them, since habit is second nature ; but they must remember that no legislative changes could be made without producing some inconvenience, and it is only by these means that they can make great progress in their political history, and an advancement in civilization ; that the world would have been stationary through successive generations had no changes taken place ; and that the greatness of England is dependent on the gradual and successive changes in her political economy ; and we must recommend to them the words of Lord Bacon in his "Essay on Innovation"*—"It is true that what is settled by custom, though it be not good, yet at least it is fit, and those things which have long gone together are, as it were, confederate within themselves ; whereas new things piece not so well, but though they help by their utility, yet they trouble by their inconformity ; besides, they are, like strangers, more admired and less favoured. All this is true, if time stood still ; which contrariwise would so sound, that a froward retention of custom is as turbulent a thing as an innovation, and they that reverence too much old things are but a scorn to the new." As well as that of Niebuhr †—"The noblest and most salutary forms and institutions, whether in civil or moral societies, when bequeathed from generation to generation, after the lapse of centuries will prove defective. However exquisitely fit they may have been, when they were first framed, it would be necessary that the vital power in States and Churches should act instinctively, and evince a faculty of perpetually adapting itself to the occasion." Man is a dissatisfied animal, and his *nisus*, or natural tendency, is to improve the *status quo*. This progressive tendency always actuates him to that, and the colonists must rest satisfied now with what they have obtained, and wait patiently until the time when their improvement will necessitate an adoption of a better and a more independent form of Government, and then their rulers will consider

* "De Augmentis," Vol. viii., p. 375.
† "History of Rome," Vol. i., p. 622.

the means best fitted for the attainment of this end, and what practical, not ideal, form of Government will be best suited to their condition, whether republican or monarchical.

Before concluding this portion of the subject—which, to use Dr. Hunt's terminology, I may appropriately call the "Negro's Place in Nature"—I must say a few words on some grave errors in generalization which men of science with restricted observation have arrived at respecting the capacity of progression of the African race. Thus it has been argued that their physical and mental peculiarities have undergone no change since they have been observed by civilised nations. "The type," says Sir George Cornewall Lewis, "is as unchanged as that of the greyhound, since the time of the Romans."* Hume, in his Essay on "Natural Characters,"† says that, "There scarcely ever was a civilised nation of that complexion (negro), nor even any individual eminent either in action or speculation . . . . In Jamaica, indeed, they talk of one negro as a man of parts and learning, but it is likely he is admitted for slender accomplishments, like a parrot who speaks a few words plainly."

Leaving unnoticed many genuine evidences of civilization to be found now-a-days, amongst the coloured inhabitants of Barbadoes and other West Indian islands, and bearing in mind that mankind (in all ages) in different communities, when subject to proper cultivating influences, do not show an equable rate of advance within a given period, I shall endeavour to point out what improvements have taken place amongst the negroes in any one of the colonies on the West Coast of Africa only within the last fifty years.

As Sierra Leone is the head-quarters of the British possession there, I shall select it as the subject of the example, and will commence from the liberated Africans, who were there freed from the fetters of slavery. Prior to their being kidnapped they were governed by kings, or chiefs, who had a complete sway over life and property; they possessed no written laws, and no proper religion, but worshipped wood, stones, and other material substances; they were extremely cruel to each other; polygamy was carried on to a fearful extent; the lower class were kept in a state of slavery; warfare was carried on in a most cruel style, and all conquered populations were enslaved; they lived in huts, made either with mud or cane; they made only one kind of cloth; they live either wholly naked, or partially so; they tilled the ground, and the Cramantees, from having gold as the medium of commerce, knew weights and measures.

On their arrival at Sierra Leone, landed naked and in a state of abject rudeness and poverty, without the least knowledge of civilization, they are placed under Government supervision for a few months. Then a portion of land is given them, to cut down the woods, and build towns; then commence cultivation; mis-

* "Treatise on Politics," Vol. ii., p. 432.
† Hume "On Natural Character," Part i., Essay 21.

sionary schools are then established; gradually they begin to read and write; commerce, by degrees, forms a part of their occupation; they slowly begin to throw off their air of serfdom, which they had imbibed from previous treatment, and become interested in the nature of their Government, so as to require improvement in its administrative and judicial departments. The worship of the living and true God is strictly observed by them, and they manifest great sympathy for the condition of their countrymen. They soon begin to inquire how their children are to be educated, and what are the best means at their disposal for doing so. These, as they grow up (which is the generation at present occupying Sierra Leone), seek after and obtain justice; preach loudly the Christian ethics—viz., mutual charity, forgiveness of one another, fraternity, and equality. Science and literature are taught in some of the schools; the generation feel themselves to possess great liberty, physically and mentally; philanthropic views are extensively circulated amongst them; they build large and expensive dwelling-houses; buy up the former abodes of their European masters; carry on extensive mercantile speculations; seek after the indulgences of civilised life, and travel in foreign countries to seek after wealth. English newspapers are very much circulated amongst them, and are read with eagerness; and they require a voice in their legislative administration. They look out for a better form for the administration of the Government, and desire to attain it, and they use the best means for attaining their wish, which form the essentials for political progress.

In the examination of the world's history, we are led forcibly to entertain the opinion that human affairs possess a gradual and progressive tendency to deterioration. Nations rise and fall; the once flourishing and civilised degenerates into a semi-barbarous State; and those who have lived in utter barbarism, after a lapse of time become the standing nation. Yes, "how wonderful are the vicissitudes which history exhibits to us in the course of human affairs; and how little foundation do they afford to our sanguine prospects concerning futurity! If in those parts of the earth which were formerly inhabited by barbarians, we now see the most splendid exertions of genius, and the highest forms of civil policy, we behold others, which in ancient times were the seats of science, of cultivation, and of liberty, at present immersed in superstition, and laid waste by despotism. After a short period of civil, of military, and of literary glory, the prospect has changed at once; the career of degeneracy has begun, and has proceeded till it could advance no further; or some unforeseen calamity has occurred, which has obliterated for a time all memory of former improvements, and has condemned mankind to retrace, step by step, the same path by which their forefathers had risen to greatness. In a word, on such retrospective views of human affairs, man appears to be doomed, by the condition of his nature, to run alternately the career of improvement and of degeneracy; and to realise the beautiful but melancholy fable

of Sisyphus, by an eternal renovation of hope and of disappointment."*

Such being the tendency of all national greatness, the nations of Western Africa must live in the hope, that in process of time their turn will come, when they will occupy a prominent position in the world's history, and when they will command a voice in the council of nations.

It remains now for me to enter into some detail respecting the wants and requirements of the different colonies on the West Coast of Africa, which the Resolution of the Committee of the House of Commons necessitates, and which would lead to those results which all wishers for the political advancement of the African race anticipate.

I shall, therefore, commence on the requirements of—

SIERRA LEONE.

I.—*The first Improvement which is loudly Called for, is the Establishment of a Legislative Assembly at Sierra Leone, with Representatives from the Three different Colonies—viz., Gambia, the Gold Coast, and Lagos.*

The Government of Sierra Leone is *de facto* a self-supporting Government, and the amount of improvement exhibited by the inhabitants entitles them to have a voice in their administrative establishment. "Nothing in defence could be urged that this or that measure is in advance of the colony; the colony was quite ripe for such improvements, the revenue was large, and the intelligence of the people advancing. The time had arrived for an extension of immunities; other colonies of later years and with a much less revenue and intelligence were politically in advance of this; they had their representatives in the Legislative Halls of a sufficient number to represent their interests. . . With respect to an extended franchise, it is most desirable that the Legislative Council of the colony should be opened to three or four members from the people, made eligible for their seats by being elected and sent there by the people as their representatives. It should be remembered that the people were ready and willing to keep up taxation in order to support the institutions of the colony, and I do not see why they do not have a voice in the administration of affairs. In short, it was the very principle of the British Constitution that those who were liable to be assessed should have a voice in the administration."†

The representative members should be nominated by the citizens

* Stewart's "Elements of the Philosophy of the Human Mind," Vol. i. chap. 4, § 8.

† Speech of Alexander Walker, Esq., in the Chamber of Commerce, Sierra Leone. Published in the *Observer*, Vol. i., p. 163.

by public votes, and a proper legislative Act will be required to guide the franchise; and the following rate of members might be recommended for the acceptance of the Government:—

Of Sierra Leone—				
Freetown should send 6 members in the Legislative Assembly, viz.:				
The City (proper)	2	„	„	„
Kissy Road .	2	„	„	„
Pademba Road	2	„	„	„
Kissy and Wellington should send 2 members in the L. Assembly.				
Hastings, Allentown, and Grafton	2		„	„
Waterloo—Benguema, and Campbell Town	2		„	„
Kent, York, Russell . . .	2		„	„
Wilberforce, Murray Town, Aberdeen	2		„	„
Gloster—Leicester and Regent .	2		„	„
Bathurst and Charlotte .	2		„	„
Of the Gambia—Bathurst to be divided in two sections—				
1. Front Street and Jolloff Town	2		„	„
2. Soldier Town, New Town, and M'Carthy's Island . .	2		„	„
Of the Gold Coast—				
Cape Coast and Dix Cove . .	2		„	„
Anamaboe, Winnebach, and suburbs	2		„	„
James Town and Christiansborg .	2		„	„
Of Lagos—				
Lagos and Badagry . . .	2		„	„

II.—*General Improvement in the Educational Department of the Colony.*

It cannot be denied that the greatest regenerative influence in this department is the Church Missionary Society. They support at present a college at Fourah Bay, a grammar school in Freetown, and a large female educational institution, besides several village schools. They have, infinitely more than the Government and than any other religious body, done a great deal for the diffusion of useful knowledge in the colony, and to their untiring exertion is due that degree of improvement which is now to be observed in the colony of Sierra Leone. It is evident from their yearly report that they could not continue this support for a long time, whilst the colony has grown to be self-supporting, and a large field is open to them elsewhere to do good; and therefore it requires that the people and the local Government should take up the work they have so admirably done.

We want a University for Western Africa, and the Church Missionary Society has long ago taken the initiative and built an expensive college, which should now be made the focus of learning for all Western Africa. The yearly expenses now of that society

for education are 4,700*l.*,* which falls short of their former expenditure, whilst the total sum expended by the local Government for this purpose is not far above 400*l.* The result is, that the educational department of the colony is greatly on the decline every year, and more support is consequently required; but the local authorities refuse to do so, although they gladly spend 14,000*l.* yearly merely for police.

A superficial consideration of the theory of the local Government for the limitation of its efforts in this important direction—viz., that extensive funds have long been, and still are being, appropriated for that object from other sources, and, consequently, it could not do so until the aid is withdrawn!!!—is so alluring and attractive that it requires a long residence in the colony to prove that it is most unsound; and should the recommendation of the Chamber of Commerce, that a portion of the revenue be yearly voted for general education, be not adopted, it will be one of the greatest barriers to the general improvement contemplated by the Imperial Government.

Fourah Bay College should henceforth be made the University of Western Africa, under the auspices of the local Government. A systematic course of instruction should be given to the students in every branch—in Humanity, *Belles Lettres*, Political Economy, &c.—by lectures; which plan I consider is the best mode of conveying literary and scientific instruction, and thus impart good moral principles in the minds of the youths under education.

In every village there should be a parochial establishment, assisted by the Government, and not dependent entirely on the paltry sums collected at the school. The schoolmasters should be better paid, so that a better class of men might be obtained as teachers, and the schools visited yearly by Government agents, to see that the rules and regulations are properly carried out.

The native pastorate† is the Established Church of Western Africa, at least of Sierra Leone, and the local Government should

* Col. Ord's Report on the Condition of the British Settlements West Coast of Africa—Sierra Leone.

† The native pastorate is unfortunately placed under a most difficult condition by their parental head, and it strikes the wonder and admiration of every one who studies its working how they have been able to exist. It is most likely that the parent committee's idea is that the pastorate should begin under hard and trying difficulties, so that when a greater laxity of privileges is granted them, the whole working of the system will go on with greater ease and success. At present, with the exception of Kissey and Regent parishes, all the most flourishing churches are under the supervision of the parent committee, and are not included in the pastorate; it has no representative church in Freetown, under the immediate control of the bishop of the diocese; and as the whole of the wealth of Sierra Leone is at Freetown, it is a great drawback to their financial success. Having no immediate interest in that body, we find that the wealthy merchants are lukewarm and sparing in their donations; Kissy-road, Pademba-road, Wilberforce, and Waterloo are still under the parent committee. But we hope that ere twelve months have elapsed the committee will adopt the wise and all-important step of handing over one or other of the two parishes at Freetown to the native pastorate.

now bring it under the same pale, and allow it those grants and privileges which are necessary to keep up the Church of the State. Col. Ord in his report said that the colony had voted a sum in aid of the Establishment, when it is positively known, and the Secretary also assured me, that they received not a farthing towards their support from the local authority.

The sum of 4,000*l.* voted yearly will be sufficient for some time to supply the wants and requirements of the ecclesiastic and educational department of the colony—viz., 1,000*l.* for the native pastorate, and 3,000*l.* for educational establishments. Of the latter, 1,000*l.* will be ample for the part payment of principals and Regius professors, who should be selected by the Church Missionary Society, and should also derive a fractional amount from their lectures. Two sections should be formed, and the lectures delivered during each of them, and the students pay a certain sum for their tickets to each lecture, as is done in other universities.

III.—*The Formation of a Municipal Council.*

The time is perfectly ripe when Sierra Leone should have a town corporation, since the existence of such a body in a country is a true sign of advance in political matters, and we hope that no narrow-minded prejudice will prevent its immediate establishment. The Gold Coast once formed themselves into a corporate body, through the recommendation of Sir Benjamin Pine, which worked a great deal of good amongst the population, but which was made null and void by Mr. Andrews during his short career as Governor of that place. Sierra Leone, from its rate of mortality and the necessity for a vigilant sanitary police, requires a town council and a medical registrar. It will root out the pernicious causes of the diseases in the colony, will relieve the police-court of a great many of its cases and officers, and consequently will save the colony a fair sum of money. The benefit derived from the summonses, fines, &c., after paying all expenses, should be used entirely for renovating the town, clearing it of filth and dirt, &c. We hope that this will be the first measure taken by the Executive authorities. One writer has remarked that there should be a certain amount of knowledge prescribed to those who emulate the appointment of Lord Mayor, alderman, and councillors; this I entirely approve of, as it will have a most beneficial result.

IV.—*The Transfer of the Registrar of Births, Marriages, and Deaths from the Legal to the Medical Profession, and the Establishment of a Health Officer.*

The beneficial result which will arise from this transfer cannot be overrated. Ever since the formation of this office, the population have been kept perfectly ignorant of the *rationale* of the registration—viz., the rate of mortality, the different causes of death, the proportion of births to deaths, the amount of legitimate or illegitimate births; the causes of periodic endemic diseases—in fact, there has never been a generalised summary published, half-

yearly or yearly, for the benefit of the people. It is certainly impossible for the legal mind to classify diseases, to trace their causes and to point out their remedy. This truth is acknowledged in England, where none but medical men have the appointment. The books in the office as it now stands are almost a dead letter to the population, but which might hereafter be used for references, and may serve as a means for drawing up a comparative statement of the health of the colony at various periods.

A medical officer of health should also be attached to the registrar's office; and I think no place requires this appointment more than Sierra Leone. The officer thus appointed should be made to give a half-yearly report to the Town Corporation of the state of the colony; and should recommend the best means of averting any danger. A legal mind could not cope with these facts; and now that no plea can be made against the non-existence of efficient public medical men in the colony, I think that the Executive cannot do better than give the office to Dr. Smith, a Sierra Leone bird, and a promising general practitioner.

V.—*The Extension of Colonial (British) Protection to the Merchants in the Rivers in the Neighbourhood of Sierra Leone, and consequently the Extension of the Custom-Office to those Places.*

It must be very provoking to think that nearly within gunshot of the barracks at Freetown, British merchants could receive no protection from the Government; that they could be tried and flogged by the natives, and their goods confiscated, without receiving any redress from the local authority, as is exemplified in the late outbreak in Mellicourie River. Proper steps should now be taken to prevent such disturbances, and the merchants, I think, are perfectly ready to pay into the colonial coffer duties on goods landed in those rivers, should they be guaranteed protection.

Most of the chiefs of those places have broken faith with the Government, have maltreated British merchants, have been conquered by our arms in different engagements, and have asked protection from us. Will it not be right that we should give them that which will be a boon to the colony? I think it is time that these trading ports should be made an integral part of Sierra Leone, since the merchants do more extensive business there than in the colonies.

Gallinas, the Searcies, and Mellacourie, should be united to the colony, whose territorial boundary will then be considered properly remodelled, and the administration of the Government will be more efficient and economical; the colony can guarantee the merchants there sufficient protection if a plan like the following be adopted:—

Let a Militia force of 100 men be enrolled and paid by the colonial Government at the rate of 1*l.* 10s. per month, which should include rations, &c.; let the men be furnished with bed, blankets, and rug; let them be properly officered, and distributed at the rate of thirty to each station; let the officer who will be the commandant be properly paid, and be made also the Custom-house

officer in those rivers, with strict orders not to interfere in the native quarrels, but to protect British property. Each vessel as it proceeds up the river should hand over its manifest to the safe care and keeping of the commandant—should give him also an inventory of the goods in the vessel, with their true value, and a written declaration attesting their truth, and a bond signed; that, should it prove false, they were to be liable to a heavy fine. They should be required to pay an *ad valorem* duty of three per cent. on all goods except tobacco and rum; it should be made optional to those who are well known in the colony to pay to the commandant in cash the amount of the duty, or give an order to their principal at Freetown.

That all vessels coming within the territorial boundary to trade should be made to pay the *ad valorem* duty, the commandant might be provided with a boat, &c., and such other arrangements should be made as the Executive thinks necessary.

Granting that the Governor-General has at his disposal an inter-colonial steamer, according to the Resolution of the House of Commons Committee on Western Africa, the steamer should be sent monthly to these stations for the conveyance of letters and orders, and for the collection of the revenue from customs. The very fact of this monthly visitation will have a moral check over any outbreak amongst the natives.

What will be the result of these measures?—

1. That the revenue of the colony will be increased from 40,000*l.* to at least 60,000*l.* yearly.
2. That the British merchants will have proper protection.
3. That the influence of the colony will be greatly extended.
4. That merchants who have hitherto been afraid to venture on the river trade will now make a beginning.
5. That the resources of the country will be better developed.
6. That the political situation of the colony will be greatly on the advance.

VI.—*The Abolition of the System of Sending the Liberated Africans to the West Indies, and the Re-introduction of the Apprenticeship System.*

According to the present system of the Mixed Commission Department the recruits, as soon as they are landed from the slave-ships, are sent to the Government yard at Kissy, where they are kept for two, three, or even four years, until they have escaped three chances of being sent to the West Indies. In the Government yard they are kept in total ignorance and idleness, although they are fed and clothed. They are not permitted to go to any school, nor are they taught any useful mechanical works in the establishment; the consequence is, that when they leave, they are seldom of any use to themselves or any one else. This system requires a radical change, and the colony requires their recruits more within the colony than out of it.

There should be formed an industrial establishment at the moun-

tain village of Gloster, under the supervision of the Church Missionary Society, paid from the Imperial chest, where paid carpenters, shoemakers, masons, blacksmiths, wheelwrights, &c., are to be continually kept at work. The superintendent should be a practical German mechanic, a type of those of the Basle Missionaries at Accra. The recruits should first be sent to the Normal School at Kissy, where, after learning to read and write for one year and a-half, they should be sent to the Industrial School at Gloster to be put to a trade, and be kept there for four or five years, and so these useful arts might thus be taught with great advantage to the colony.

The establishment might be made partially self-supporting by each department of trade being made to receive works from without through the superintendent; the tailors should be made to sew the gaol clothes; the carpenters can be put to Government building and repairs, &c. The female recruits should be placed at Charlotte School, and after a year and a-half of training in needlework, reading, and writing, be distributed amongst different families.

VII.—*The Formation of a Dry Dock in Freetown.*

The material for forming a dry dock is abundant in Freetown, and as there are no docks in the whole of Western Africa, I think that if a proper one is formed it will be well patronised, and bring a good revenue to the Government. This will of course require a good outlay, which will be returned to the local Government in kind in the course of a few years.

Krew Bay would be the most fitting place that could be selected, and a yearly grant of 3,000*l.* or more will soon erect an extensive dock, which will be serviceable to men-of-war and merchant vessels, and which will increase the knowledge of shipbuilding in the colony.

VIII.—*The Building of a Sea-front Promenade.*

There is no town on the Coast in which the sea-frontage gives so dull and unhappy an appearance as Freetown, especially during the rainy season. We find here a tumble-down building, there a half-finished store; here broken rocks and upheavals of the earth, there an inroad of the sea into the town. We find nothing in a regular form, but every thing pell-mell. We propose that an agreeable walk be made along the sea-frontage, which might be made either a private or public thoroughfare, and that seats be properly arranged in it; if private, that each family pay to the Government the sum of one or two guineas a-year for the privilege of using it.

IX.—*A System of General Supply of Water to Freetown should be Adopted.*

This must either be done by Government, or by a private company, but as the former is better able to do it, we hope that it will not be long before it will make a beginning. In dealing with the subject of the water supply in the Chamber of Commerce, Mr.

Walker remarked that it will not only be ornamental, but extremely useful in a sanitary point of view; it will supply the wants of the thousands who weekly attend the market, and will more effectually clear the cesspools of their filth and dirt, and consequently improve the general health of the colony. It is a project that will be most easily accomplished, as Freetown is a gradual slope from the hills, and several beautiful streams run down through the town from the mountains. With very small outlay, reservoirs, with pipes, could be easily laid down, and the water conducted into the different parts where it will be required.

X.—*An ad valorem Duty of 4½ per cent., or 10¾d. in the Pound, to be charged for Merchandise, with the Exception of Spirits and Tobacco.*

It has been recommended to the Executive authority by the Chamber of Commerce,* that a uniform *ad valorem* duty of 2½ per cent. should be charged on all goods, except spirits and tobacco. This, I think, is too small, and would tend to reduce the revenue a great deal, whilst it is the interest of the colony to have it increased. A uniform duty will, no doubt, tend to facilitate the business of the Customs and merchants; and will also procure a saving to the Customs department, and, therefore, we recommend for adoption the payment of an *ad valorem* duty of 4½ per cent., or 10¾d. in the pound.

XI.—*Proper Measures for the Encouragement of Agriculture and Good Building, as Recommended by the Chamber of Commerce, should be Adopted.*

XII.—*The Raising of a sufficient Amount of Money for rapidly Carrying out those Improvements which are Essential to the Health and Industrial Development of the Colony.*

It will be observed, from the reading of the above pages, that the colony will require a large amount of money at once to carry out these useful improvements, over and above the present revenue. A loan has been suggested by many, but the colony will be obliged to pay a large interest until the capital is paid; and this will necessitate an increase in the taxes. In my opinion this can at present be dispensed with if the amount required be not far over 40,000*l.*, and let the colony be her own debtor.

Let a colonial paper currency to that amount be issued, and made equal in value to the specie in circulation, and redeemable in ten or more years; let the Legislature be stringent in preventing any depreciation of its value; let the large mercantile establishments take it up and have it circulated, and let the Government redeem every year from two to four thousand pounds; and in a few years those large improvements indicated will be made, which, in the course of a short time, will pay their own expenses without any outlay from the colonial chest. A similar plan was, some

* Chamber of Commerce Report, January, 1865.

years ago, adopted in the building of a large wharf (if my memory be correct) in Jersey, with great success.

It might be remarked that whilst I condemn the practice in Liberia of a wholesale issue of paper currency,* I recommend the same thing at Sierra Leone. But there is a great difference between the two countries. The former, having a very small revenue, issued an amount of this medium far above her capacity for redemption, and not for the building of any public works which would pay their own cost, but to avert a crisis. The latter, on the contrary, has a large revenue, which is above her expenses, and a few years ago she had in her chest about 15,000*l.* over and above her expenditure. The paper currency, if adopted, will be for building public works, which will be made to pay their own expenses, without costing a farthing to the Government. Thus, if water be conveyed to the town and supplied to the different houses, the people will be taxed for it, and the money derived from it will go towards reclaiming the paper currency, until it becomes an independent source of revenue. I shall, therefore, recommend the adoption of this measure as the most practical that could be found suited for the colony of Sierra Leone, and do not venture at present on a loan for these improvements. I shall, however, in another place point out where a loan might with the best advantage be contracted.†

There are many other improvements‡ which might be recommended, but which I must leave for the deliberation of the Legislative Assembly, which every one hopes will soon be formed, and must go on in the consideration of the requirements of the

GAMBIA.

I.—*An Increase in the Duty on Ground-nuts from One Penny to Twopence per Bushel.*

The Government of the River Gambia has been almost in a state of bankruptcy for the last two years, and this is mainly to be attributed to a mistaken legislature. Prior to this period, the merchants paid an *ad valorem* duty of four per cent. on all articles except tobacco, spirits, &c. Subsequently, however, a duty of three farthings (!!!) a-bushel on ground-nuts, now increased to one penny, was substituted, as the French mercantile firms at Bathurst were purchasing ground-nuts with specie, and thus escaped the duty which the English houses who import largely dutiable goods had to pay. The duty on ground-nuts, instead of being only one penny, might, with advantage to the colony and without any pressure on the merchants, have been placed at twopence per bushel, which would in a short time pay off the liabilities of the colony, and would leave a small yearly balance for carrying out sanitary improvements.

It will, I must confess, be very difficult for the present Executive head to carry out in Council such a useful step, as the mercantile interest is so well represented in Council, that he will meet with strong opposition.

II.—*The Formation of a Municipal Council at St. Mary's.*

This will have a most satisfactory effect on the general population, and would tend to improve the general health of the colony; a town mayor is very much needed at Bathurst.

The appointment of a Municipal Council will be useful in clearing out the rubbishes from the town; in completing the different drains; and in making proper roads to the different villages. With its appointment should be the re-establishment of the assistant-colonial surgeoncy, which has been imprudently abolished, when the colonial surgeon alone is insufficient for the amount of work required to be done. The assistant-colonial surgeon should also be made inspector of cesspools or sanitary officer, since if there be any place on the whole Western Coast which requires an active sanitary officer, St. Mary's does.

III.—*The Formation of a Militia Force for the Protection of the River Trade.*

As the abandonment of the Island of M'Carthy, 180 miles in the interior, and the encouragement of the inhabitants of a self-supporting system, form a prominent feature in the resolution of the late committee, the merchants at Bathurst, who have derived such great advantage from the trade, should now undertake to have in the rivers such a sufficient native force as will give a moral protection to their trade without meddling with the native Government; they have in the colony steady and able young men to form efficient officers (such as the Lloyds, Hughes, Stubbs, &c.), if properly paid. The merchants would thus only lay out a trifle out of their yearly profits. With the sum of 2,000*l.* they could could maintain an efficient force of sixty men, which would be sufficient for all the purposes they might require, viz.:—

* *Vide* above, Liberia, p. 10. I am glad to be informed that Liberia is now making an effort for the redemption of her paper currency.

† *Vide* below, Gold Coast.

‡ Mr. Rosenbush, in a letter to F. Fitzgerald, Esq., remarked that the greatest requirement of the colony is agriculture, and he recommends the establishment of a model farm by convict labour. "At present," he said, "the characteristic feature of the inmates of the gaol is to make the institution a kind of refuge;" availing themselves of the "temporary leave of absence," they go out, but invariably soon return, on account of being worthless for honest employment. In a model farm they would first work to maintain themselves, and, secondly, become acquainted with agriculture, which might induce many to remove to parts where they are not known, and endeavour to regain an honest position in life. The expense of one could scarcely be more than the amount which the establishment of the Colonial Government now costs, and the firm would very soon become self-supporting. It should be open for inspection of everybody, in order to stimulate others to follow the useful employment of agriculture.—*African Times*, August, 1865, p. 14.

Two Sergeants at 2*l.* 10s. per month	£60	The sum thus made up, yearly :— Messrs. Forster and Smith	£300
Four Corporals at 2*l.* per month	80	Thos. Brown, Esq. . .	300
Sixty Privates at 1*l.* 10s. per month	1,080	David Brown, Esq. . .	300
	£1,220	T. F. Quin, Esq. . . .	300
One Captain, at per year	350	M. Morrell	300
Two Subalterns at 250*l.* each	500	C. Chön, Esq.	300
		W. F. Goddard, Esq. . .	200
		C. Vermie and Co. . .	100
		J. Melbury, Esq. . . .	80
		J. Dodgin, Esq.	50
Total . . .	£2,070	Total . . .	£2,230

Thus, 2,230*l.* against 2,070*l.* of expenditure.

Of the sixty men, thirty can be stationed at M'Carthy's Island; twenty at Alberda, and ten at Bathurst; which would secure the interest of the merchants along the whole trading course of the river. The non-commissioned officers should be those who were pensioned from the West India Regiment, a goodly number of which are to be found at Bathurst.

The captain commanding should have the sole charge of the northern district, subject only to the orders of the mercantile Council at Bathurst. He should hold the post of civil commandant, and should receive the pay of 200*l.*, instead of the present 130*l.* One of the subalterns to be at Alberda, and the other at Bathurst. By these means the merchants will have their interest well secured in the rivers, and if their officers keep from interfering in the natives' quarrels their trade will be greatly increased.

IV.—*The Postal Regulations of the Rivers should be Re-organised.*

Unquestionably the postal arrangement along the River Gambia is the most irregular along the whole Western Coast of Africa, and although there is a steamboat lying at Bathurst harbour, expressly for the use of the river, the delivery of letters is in the most precarious and laxed state.

There is by far a greater degree of regularity in the postal arrangements between the newly-acquired territory of Sherbro than has ever been observed in the stations on the River Gambia. One who resides there is required to have a friend at Bathurst to receive his letters and papers before he can expect to receive them, or they may remain at the post-office for several months until claimed. On the Gold Coast, twice a-week, letters leave the post-office at head-quarters for the different out-stations, and the Government is well supplied with the conditions of its outposts. This postal arrangement, or what might properly be called disarrangement, is a great drawback to the improvement in the colony, and the sooner it is remedied the better will it be to all concerned.

V.—*The Appointment of Two Representatives to the Legislative Assembly at Sierra Leone.*

The requirements of the

GOLD COAST.

The Government of the Gold Coast has always been regarded as the most difficult and intricate of all the Governments on the Coast; but if it be closely and quietly investigated, it will be found that most of the ado which has from time to time been the cause of these misunderstandings between the natives and the Government had been occasioned by the Executive authority exceeding the charter of the settlement.

The British Gold Coast is merely a protectorate, the natives having their own kings, using their own laws, and performing their time-honoured customs; beyond the Fort gate we have not a foot of ground in the country. After the turbulent period, previous to 1830 and the peace proclaimed between Ashantee and the natives through British influence, the inhabitants submitted themselves to the British Government, not as subjects, but as independent nations, in alliance with, and protected by, the United Kingdom of Great Britain and Ireland, without any stated laws respecting their Government; and the chiefs have always looked upon our Sovereign as a kind of feudal superior, against whose enemies they were bound to fight when called upon, and who was in turn bound to aid them in case of trouble from within or without. The treaty between the British Government and the native chiefs distinctly stipulates that the natives are to be governed by their own laws, except in certain cases plainly specified. But we find that each Governor rules according to his own idea at the time being, and much of the difficulty has arisen from excessive interference with the powers of the native kings and chiefs. I shall, however, detail what course, if pursued, will make it the most simple Government on the Coast.

I.—*That the Governor-General of the West Coast of Africa should Negotiate with the Dutch Governor for the Purchase of the Territory on the Gold Coast.*

It has always been remarked, with great truth and justice, that of all the Governments on the Coast of Africa, none is more inimical to the moral and intellectual improvement of their subjects than the Dutch Government; and whilst valid improvements might be traced in the English and late Danish possessions, the Dutch subjects are in total ignorance, and are left entirely to follow their own superstitious ideas. No missionary is permitted to live amongst them, nor are there any schools worth noticing for the benefit of the rising generation.

Through their rule (misrule, I should say) they have prevented

our Government from raising a sufficient amount of revenue that would soon quadruple the present expenses of the Government, and supply the means of making roads into the interior ; increase the stability of the local Government, and make a great improvement in every portion of its Executive administration. Without the Dutch, a revenue of 60,000*l.* could with ease be raised from the Gold Coast, but so long as they occupy those forts they will always remain the greatest barrier to improvement.

The Dutch Government and Chambers dislike the yearly vote of 12,000*l.* for the expenses of their settlements, which bring them nothing whatever in return, except some 400 slaves, for which they pay 40 dollars a-head yearly, to recruit their East Indian force in Java. Let the Governor-General propose to pay the Dutch the sum of 50,000*l.*, in three instalments, or at once, for their settlements ; let this amount be placed in the market, at certain percentage, through one of the leading banks, and a loan contracted, the greater part of the new impost to be placed towards the paying of that amount, and I have no doubt that, within ten years, the whole of the debt will be cleared. It is the cry of the merchants, as well as chiefs, in the British territory, that this should be done, and the Dutch subjects will hail it with enthusiasm.

II.—*That the Kings of Cape Coast and Accra should be made ex-officio Members of the Legislative Council.*

This will be a great step towards carrying out the proposal of the House of Commons Committee, and much of the misunderstanding and difficulties to which the Governor has hitherto been liable will be averted. At present, Cape Coast has got an educated Christian king, and I consider this the most fortunate thing that could have happened to the Gold Coast at this crisis.

At James Town, Accra, King Cudjoe is a [redacted] illiterate old man, who could not, with dignity, be installed into such a high post; but at Christiansborg, King Dawoonah, who now rules, is an educated man, who has spent several years in Denmark, and has travelled in the Danish man-of-war to different parts of the West Indies. It was the custom of the Danish Government to give a sound education to the Prince and heir of the throne of Christiansborg, and so enlarge their views about Government. Dawoonah had all these advantages, and therefore no king could be more suited than him to be appointed a member of the Legislative Council in the Eastern district.

III.—*An Assemblage or a Congress of Kings should be Held at Cape Coast, and one at Accra, for the Consideration of Matters relative to the Good of the Protectorate.*

The great difficulty found in the Gold Coast is caused by the Executive ignoring the authority of the kings ; thus, during the Government of Mr. Andrews, a king of an important district was heavily fined, and almost imprisoned, through the misrepresentation of one of his subjects ; a petty commandant had power to

summon a distant king from any part of his imperial rule, have him brought to his petty police-court, and fined heavily for some charge his subjects might bring against him. This Mr. Pine has endeavoured to prevent; and such treatment to the kings every one must acknowledge as most injudicious, unreasonable, and impolitic, as well as most damaging to the British influence on the Coast. The effect is that the Governor, instead of being loved, is hated and abused, and his proclamations are trampled under foot.

I say, therefore, that a congress of the kings of the protectorate should be assembled for the consideration of subjects relative to the benefit of the protectorate, one at the head-quarters of the western district—viz., Cape Coast, and the other at Accra, the head-quarters of the eastern district.

At Cape Coast should assemble the Kings of Wassan, Dix Cove, Denkera, Assen, Mansoo, Anamaboe, Abrah or Abacrampa, Mankasin, Agimacoo, Western Akim, Essicoomah and Akiunfudie ; presided over by the Governor—at Accra, the Kings of Crobboe, Aquapem, Aquamboe, Adda, Eastern Akim, Goomon and Winnebah ; presided over by the Governor.

I shall here only detail the subjects for consideration, without attempting to enlarge on their necessity :—

1. That the King of Cape Coast be admitted head of all the kings of the western district.

The advantage of this is that in cases where there is an obstreperous king of the western district the Governor has only to apply to the King of Cape Coast, who would more easily see his instructions carried out with very little expense than the Governor of Her Majesty's Forts and Settlements.

2. That the King of Accra (at present Dawoonah, King of Christiansborg, Accra) be admitted the head of the kings of the eastern district.

3. That the kings should bind themselves to defend one another against a common enemy.

4. That should any quarrel arise amongst themselves, the aggrieved party should inform the king-in-chief, who should, if necessary, call together the other kings ; and the guilty party should suffer the penalty inflicted by their decision, subject, however, to the approval of the Governor of Her Majesty's Forts and Settlements.

5. That the extradition of all political offenders and political refugees of the King of Ashantee be strictly enforced.

6. That there should be made a broad road from one town to the other by the male subjects of each town, in default of which a fine is to be inflicted.

7. That the kings should be prevented from executing capital punishment; but when any one has shed innocent blood, he has to be forwarded to the British authority, where he has to undergo his trial, and if found guilty, to be forwarded to the place where the crime was perpetrated, and there hanged.

8. That the commandants be prevented from sending a summary summons against a king to appear in his court, such being deroga-

tory to the regal authority. That in any case of complaint he should report the same to the Governor, who should give it his early attention.

9. That the king's person should be regarded as sacred, and that he should on no account be arrested by any warrant, either from a commandant or from the Supreme Court, except he rebels against existing authority.

10. That immediate obedience should be required of every king to the Governor's summons, or that of the king-in-chief, in default of which a heavy fine to be inflicted.

11. That the inhabitants should have a right of appeal from the king's court to the Commandant or Stipendary Magistrate Court, but no judgment of the king's court to be set aside unless the case is thoroughly sifted, and a report filed in the king's court.

In such a case the appellant should be required to deposit a certain amount for costs, unless he pleads *in forma pauperis*.

12. That the kings should forward to the Governor the names of their magistrates or other officers of their court, as well as whatever changes they might from time to time, as circumstances may necessitate, make.

This refers especially to the seaport towns, Cape Coast, Dix Cove, Anamaboe, Winnebah, and Accra.

13. That in those places above-named the king should not sit as magistrate, but that his court should be formed of educated men; and that in any difficult cases reference should be made to him in person.

14. That proper means should be adopted to keep intact a friendly relationship with their powerful enemy, the King of Ashantee.

IV.—*That there should be Placed a Resident Consul from the Gold Coast Government at Coomassie.*

The frequent disputes which have arisen between the Ashantee potentate and the Governor of Cape Coast have pointed out that the best means for keeping the two powers in peace and amity is to have a consular agent at Coomassie, and none but a native of good education who could speak the language fluently should be appointed. Hitherto the policy of the Governors with the king is generally carried by the former sending a letter by an interpreter, who understands very little English, and in many cases could scarcely understand the language made use of in the letter: he therefore interprets it according to his own idea of the sentence, and in a great many cases puts an entirely wrong meaning to it.

These mistakes of interpreters are of everyday occurrence in the court, and great palavers on the Coast when the interpreters are unlettered, and are generally corrected by the educated natives. The consul should be allowed a clerk; should be paid from two hundred and fifty to three hundred a-year; should have four months' leave of absence at the end of every two years, with his expenses paid to the Coast. He should be paid out of the revenue

of the colony, and his actions be under the immediate control of the Governor.

V.—*That the King of Coomassie be induced to Send a Resident Ambassador to Cape Coast.*

His chief business will be to seek after the interest of the Ashantee traders on the Coast; to attend immediately to any complaint they may bring to him from being maltreated by any of the kings or their subjects. The result of these two acts will be that trade will be greatly increased; that there will be greater faith and cordiality between the two Governments, and that the social and political advancement of the colony will be greatly enhanced.

The Governors should always bear in mind this Latin maxim: "Cessante causâ, cessat effectus," or, "Sublata causâ, tollitur effectus." (Withdraw the cause and the effect is destroyed.)

VI.—*That an Improvement should be Made in the Educational Department of the Government.*

At present the Colonial Government only supports a small school at Cape Coast, where the boys learn scarcely anything more than to read and write. In former years they gave the children very good education, having efficient masters; but those now-a-days do not even know the rudiments of grammar; the pay is so trifling that the educated would not think of offering themselves for the post. The Wesleyans have schools in the different towns, but they are always known to be deficient in giving instruction in the higher branches of education.

The Basle missionaries at Accra have done much, as they combine industrial pursuits with good, sound education.

The local Government should form schools in the different outposts, with properly-paid educated teachers from Sierra Leone or elsewhere, and a grammar-school at Cape Coast. The necessity for these improvements is very evident.

VII.—*That there should be Formed an Industrial School at Cape Coast.*

The Gold Coast is greatly wanting in good mechanics. There are no good carpenters or masons to be found; nor are there any shoemakers, grainers, painters, tailors, joiners, coopers, or wheelwrights. The Basle missionaries have endeavoured to supply the deficiency and teach some of these branches, but they are wanting in funds; and therefore it should be taken up by the Government, and a large establishment formed at Cape Coast, with one of these German mechanics at the head.

VIII.—*The Gold Coast should Send yearly Six Members to the Legislative Assembly at Sierra Leone.*

IX.—*The Remodelling of the King's Court into the principle of a Municipal Council.*

Through the recommendation of Sir Benjamin Pine, when Governor

of the Gold Coast, a municipal council, with the requisite officers, was formed at Cape Coast and Accra, which did a great deal of good in improving the health of the town by clearing out rubbish from the streets, by preventing nuisances being committed there, by stopping many barbarous customs to which the people were addicted, and by making proper drains. Mr. Andrews, however, when Governor, abrogated their power, and ultimately recommended to the Secretary of State for the Colonies its total abolition, which was carried; and thus a useful institution, through the caprice of one individual, was abolished.

But it is not my intention here to recommend the re-establishment of that corporate body, but that the king's court should be so remodelled as in principle to form a miniature municipal court, as this will be the best means for initiating the inhabitants into the form of self-judicial government. In fact, the King of Anamaboe, Coffee Affray, has anticipated this suggestion. "He does not settle palavers now," says the Hon. George Blankson, "but hands the case over to his judges, who are Messrs. Ferguson, Quansah, and Insaidoo Morgan." Now these three men are tolerably educated, and have large interest in the country. The king appointed Wm. Gharty, merchant, and president of the Gold Coast Temperance Society, his treasurer.

After paying all expenses, the regulation stipulates that the residue of the income is to be appropriated to the purpose of sanitary police, making roads, &c. Anamaboe, therefore, has given the initiative to the whole Gold Coast, and this plan should be recommended to the Kings of Cape Coast, Winnebah, and Accra.

The requirements of

LAGOS.

The colony of Lagos is an embryo colony, and its wants and requirements are yet to be studied. It will now be the place of the Governor to grant to the inhabitants privileges, as they show themselves ripe for it; but the improvements which are now called for, and which can with justice be conceded, are:—

1. To improve the drain of the town.
2. To open a good road towards Abeokuta.
3. To have trials by juries instituted.
4. Lagos should send two members to the Legislative Assembly at Sierra Leone.

THE REPUBLIC OF LIBERIA.

Whilst the British Government is planning out valuable measures, which will produce an entire change in the political government of her colonies along the West Coast of Africa, it is hoped that she will not forget that she still retains her glorious name of being the mother of nations. At the birth of the young Republic of Liberia, she stretched out most graciously a helping hand to her, and assisted the regenerated inhabitants to develop the vast re-

sources of their beauteous land, and to prepare themselves by active industry and well-spent lives to prove that they were capable of self-government and a higher state of intelligent existence.

There was perfect harmony between the young Republic and Her Britannic Majesty's Government. A consular agent was placed at Monrovia, which had the two-fold effect of representing British interest and exhibiting a laudable example to the other European powers. British vessels traded there, and British men-of-war are now and then in their harbour; and although at present the Republic has the sympathy of the British Government at heart, yet still it must be admitted that the withdrawal of the consular agency from Monrovia has operated very much against their interest.

The Honourable Mr. Cardwell, whom Providence has placed as Her Majesty's Principal Secretary of State for the Colonial Department in these difficult times for Africa, has proved by his defence of the past policy of the Government, and the good effect produced by missionary operations on the African race, that he is determined to give a new impetus to what is good, whilst at the same time repressing what is evil. We are confident that, if properly represented to him, he would recommend the re-establishment of the Consulate in Liberia; and I hope that the friends of African advancement will take an early opportunity of memorialising him on this subject.

The annexation of Sherbro to Sierra Leone, and the contemplated suppression of the office of Judge of the Mixed Commission Court in that colony, left vacant by the death of Mr. Skeleton, will place at the disposal of the Government a saving of nearly 3,000*l.* a-year, from which source the consular agent in Liberia could be paid without any pressure on the Imperial funds.

In bringing my remarks on the political economy of British Western Africa to a close, I must here adopt the remarks of a great writer, that the ambition of Great Britain in these days is to see her colonies attain one by one to the position of wealth and power, and to form themselves into nations; "it is her desire to have independent nations, once her feeble offspring, associated with her in the great work of the world's natural development, and the spread of Christian civilisation . . . . . to raise the degraded natives of Africa from the debased and degraded state to which they have fallen, both morally and physically—to free them from the bloody and demoralising influence of beastly superstition, —from polygamy—from domestic slavery—from the paralysing effects, as regards productive industry, of customs and institutions which, by the insincerity they create, as well as the licentious and foolish extravagance they prescribe and encourage, prevent the creation of that capital by which alone the works necessarily attendant on civilisation can be executed."

The African must expect to receive on the Coast from those, perhaps, who might be expected to support him, no ordinary degree

of abuses when he shows a degree of intelligent knowledge of his requirements; but he must never allow that to induce him to press his claims with arrogance, as that will be the best means of defeating his object; and I must only reiterate the advice of Mr. Fitzgerald, who urges upon the educated Africans of the Coast to put their shoulders to the work; "to prove by the effort they themselves make, that they too desire, and are striving, and will strive for the Christian and industrial regeneration of Africa; and to do this with the modesty, not at all incompatible with manly self-reliance, and a due sense of the innate dignity, which should characterise men who have been helped out of their degradation and brought at once into the ranks of a Christian civilisation which has taken eighteen centuries to be developed," by doing which, there will be encouraged the exercise of those qualities which will gradually lead to the attainment of the power of self-government, and the contemplated improvement by the House of Commons Committee will go on *tuto, cito, et jucunde.**

* Safely, quickly, and with ease.

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PAMPHLETS

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