ON THE
GANGLIONIC CHARACTER
OF THE
ARACHNOID MEMBRANE OF THE BRAIN
AND SPINAL MARROW.

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As I believe it has never been supposed by physiologists that there exists within the cavity of the cranium an especial provision of organic nerves for the supply of the cerebral vessels, corresponding to those which, in the abdomen, go from the cæliac ganglia to the vessels of the viscera,—the arachnoid serving as a membranous plexus in which they ramify,—the announcement of this view can scarcely fail to be received by anatomists and physiologists with extreme doubt. Under this impression I have considered it admissible, at the commencement of this paper, to state, that the views herein set forth are based entirely upon anatomical facts which I have endeavoured to describe in such a manner as will most facilitate the verification of their accuracy: for this purpose, also, I have detailed these facts and discussed their physiological application nearly in the order they occurred, whilst occupied in their examination.

The first idea which suggested to me the resemblance of the arachnoid to the sympathetic, was from the examination of a piece of the former taken from the inferior and lateral part of the medulla oblongata, when I observed, at the meeting of two of the chords situated between the arachnoid and pia mater (called by Magendie, "*Tissu cellulo-vasculaire sub-arachnoide*"), a triangular body of the form and general appearance of a ganglion, very similar to such as I had seen in small animals.—(See Plate II. fig. 5.)

This resemblance appeared more striking on observing a branch going from the chord connected with this body, to the arachnoid membrane, along which it ran for a considerable distance, dividing and subdividing in its course, in the manner of a nerve; the successive subdivisions becoming more and more minute, and at the same time interlacing and enclosing small areolæ filled with corpuscular matter. These corpuscles were so blended with the ultimate filaments of this chord as to render indistinct their exact mode of termination.—(See Plate II. fig. 4.)

Such was the connection of one extremity of one of these chords. The next point to be determined was the structure to which the other extremity of the same chord had been attached. As, in this case, it had been separated from its connection, this could only be ascertained by examining similar chords in other portions of membrane. This examination being made, I found that the end in question terminated either on an artery or on a cerebro-spinal nerve. In the former case a chord, as soon as it comes in contact with an artery, divides into branches which ramify upon it, and run along its external coat, just as, to all appearance, the branches of the solar plexus do on the small arteries supplying the viscera in the abdomen.—(Plate III. fig. 1.) If the cerebral artery be rather large, and situated between the arachnoid and pia mater, some of the branches going from a chord form upon it a plexus, and others proceed onwards to the vessels of the pia mater.

In some instances a chord passes from an artery to the

arachnoid without dividing in its course, as just described ; but more frequently on approaching the latter it sends off three or four large branches, which pass to different parts of the membrane, and ramify in it, as before explained ; however, sometimes one of these branches either itself expands into a large dense plexus, or joins other branches to form one, from which plexus two, three, or more chords pass into the substance of the arachnoid. The shape of these plexuses is either square or triangular, according to the number of branches which join them, and the number they give off. Besides consisting of interlacing fibres, they also contain corpuscular matter.

The arachnoidal extremity of some of the chords connecting the vessels with the arachnoid of the cauda equina expands close to the membrane, into a large oblong and rather oval bulb, the axis of which is occupied by a continuation of the chord, extremely convoluted and bent upon itself ; whilst, inferiorly, its fibres are blended with those of the membrane. —(See Plate II. figs. 7 and 8, which exhibit representations of two of these expansions.)

The chords which pass from the vessels of the pia mater, at the upper portion of the brain to the arachnoid, terminate in the latter by fibres having a stellate arrangement. There are also some large triangular plexuses like those at the base of the brain, from which branches descend between the convolutions to the vessels within the sulci.

In the lower animals, as in the sheep, in which the cerebral convolutions are small, the stellate fibres are the best seen. They can even be distinguished by the naked eye, appearing like minute opaque points. At their centre, the fibres of which they are composed, seem to be blended into an irregular confused mass, from which other fibres radiate, and lose themselves in the cerebral surface of the arachnoid. Some fibres go from one stellate body to another, and others can be traced into the coats of the vessels : these latter are by no means numerous. Branches also descend (still having somewhat the stellate disposition) between the convolutions, to the

deep-seated vessels ; these filaments are much more numerous upon some vessels than upon others, and they do not appear to extend so far as the capillaries, no fibres of any kind being visible upon this system of vessels.

It appears, from what has been stated, that the disposition of the ramifying filaments of the arachnoidal chords, and the form and size of the gangliform plexuses connected with them, bear some proportion to the number and size of the vessels in their vicinity. Hence, about the base of the brain, where the branches of the arteries are large, the plexuses are also large, and of an irregular shape, whilst on its upper surface, where the vessels are comparatively small, and more equal in size, and have a more uniform distribution, the plexuses also are smaller, more numerous, and more regular in their shape and volume.

Besides the plexuses situated in the course of the chords of the arachnoid, there are others which are more intimately connected with its cerebral surface, and which, in some situations, appear to compose the entire thickness of the membrane.

In these plexuses, the filaments interlace very much in the same manner as the nerves do in the plexuses of the cerebro-spinal and sympathetic systems. A chord, for instance, when traced into one of them, will be observed to break up into its component filaments, the adjoining bundles of which interlace, yielding to one another one or more bundles, and the chords which emerge from the plexuses deriving their component filaments from different bundles : these bundles, and their component threads, during their interlacing, will be seen to preserve their individuality.—(See Plate III. fig. 6.)

When a chord going from the arachnoid, terminates on a cerebral nerve, it divides in the same manner as on an artery, some filaments ascending and others descending, along with the nerve tubules. In some instances this extremity terminates in a sort of membranous expansion, which encloses several nerve tubules.—(Plate III. fig. 5.)

As this apparatus of ramifying chords and plexuses is neither vessels nor cerebro spinal nerves, it occurred to me that it must, therefore, be either cellular tissue or organic nerve fibres. By cellular, elastic, or filamentous tissues, considered simply as such, physiologists understand a structure whose office is exclusively mechanical.

Now, it appears to me quite obvious, on considering the relations of these chords and their appendages, with respect to the parts to which they are attached, that they are intended to perform something more than a mere mechanical office.

Some of these chords are three-fourths of an inch in length, whilst, between the vessels on which they ramify and the arachnoid, when these parts are in their natural situation, there is not, probably, a quarter of that distance.

Besides, the dense and comparatively massive plexuses, which are situated in the course of some of these chords, and the expansions into which others terminate, just before they join the arachnoid, cannot in any way strengthen the connection between the membrane and the vessels, or enable the one to support better the weight of the other.

It is possible, that any one who may have observed the "tissue cellulo-vasculaire" only in a general way, may suppose it to be intended merely to divide the space which contains the cerebro-spinal fluid, as the cancelli do the cavity of some bones. There appears, however, no resemblance whatever in these structures which warrants such a conclusion.

Lastly, the circumstance of these chords dividing and ramifying like an artery or a nerve, is a character which is not possessed by mere fibrous bands in other parts of the body. Mandl, in speaking of the characters of cellular membrane, observes, "*Les fibrilles du tissu cellulaire ne se ramifient jamais.*" This character, more especially when viewed in connection with the fact of many of these chords being connected with plexuses, seems to indicate that they are concerned in the performance of some vital function, the ramifications at one

extremity of a chord being to collect some influence generated in the arachnoid; and the trunk, and the ramifications at the other end, serving to convey and distribute that influence to the parts requiring it, or, in other words, that they perform the function of nerves.

For the purpose of testing the correctness of this conclusion, I compared the filaments composing these chords, and various parts of the arachnoid itself, with nerves undoubtedly sympathetic. The comparison was made chiefly with branches from the solar plexus, both in the human subject and in other animals.—(Plate II. figs. 1, 2, and 3.)

In the chords of the arachnoid, I could distinguish three different kinds of filaments, all which exist in the branches of the sympathetic.

One species generally considered the most characteristic, is the nuclear fibre described by Henle; it is a flat, clear fibre, with oval, nearly equidistant nuclei, and each having its long axis corresponding to that of the fibre. I have found these fibres in the arachnoid, but they are very rare. I have seen such going from the arachnoid to the coat of the internal carotid, the trunks being blended with the membrane, and the branches connected with the artery. I also found, that as the fibres branch off from these trunks, and intermix with others, they lost their nuclei, became more pale and clear, and differed in no respect whatever from the other fibres of the membrane. Besides, I have seen these fibres in other parts of the membrane, and they exist chiefly on the exterior of the larger chords. (Plate II. fig. 10, represents some of these fibres as found in the chords of arachnoid.) This species of fibre I have also found to be very uncommon in the smaller branches of the nerves confessedly sympathetic, especially in those most remote from the ganglia and larger trunks. The next kind of fibre is one consisting of bundles, for the most part rather smaller than nerve tubules, of very minute wavy filaments, intermixed with small particles of granular matter, having no definite form, size, or position in respect to the filaments. Some of the chords of the arachnoid are made up entirely of

fibres of this description ; in others they exist chiefly on their surface, being most abundant near their attachment to the arachnoid, upon which they are continued. This kind of fibre exists abundantly in all the branches of the nerves undoubtedly sympathetic ; and also, more or less, in those connected with the ganglia. The third kind of fibre occurs in the form of roundish, though sometimes flat chords, composed of extremely minute wavy filaments, either collected or not, into bundles, but apparently interwoven somewhat together, so that, generally, a filament of only an inconsiderable length will admit of being detached mechanically from the rest, and, when thus separated, its breadth is very unequal, and its contour ill-defined. These filaments are often totally destitute of granular matter.

This last species of fibre is very common among the chords composing the plexuses of the arachnoid ; it is also sometimes situated in the centre of the larger ones, surrounded by the second species of fibre ; this can be detached mechanically, and exhibited separately under the microscope.

In the nerves obviously sympathetic, this kind of fibre exists in considerable abundance in those branches of the solar and other plexuses which are most remote from the ganglia.

After having satisfied myself of the resemblance of the fibres of the arachnoid to those of the branches of the sympathetic, I exhibited some preparations of both structures, that is, both arachnoid and sympathetic fibres, to different anatomists, some of whom pronounced them to be merely cellular, or elastic tissue, and others to be decidedly organic nerves.

This discrepancy of opinion, partly due to a notion which is entertained by Henle, that the sympathetic is only to be distinguished by a particular form of nuclear fibre, induced me to re-examine this subject with every possible care.

Although aware that Henle's opinion does not agree with some of the more recent examinations of this nerve by other authors, I shall, in the place of referring to authorities upon

this point, briefly give the result of my own investigations, and the manner in which they were conducted.

A part well adapted for the examination of the sympathetic, is one in which a considerable length of nerve can be displayed continuously; the mesentery of the cat, or rabbit, presents this advantage. Having dissected out branches of the mesenteric plexus in these animals, extending from the centre of the mesentery to the intestine, I examined them in such a manner with the microscope, as always to be certain, by their continuity, that the part under observation was sympathetic nerve. In these nerves, and their various branches, I could distinguish the three descriptions of fibre already mentioned, and which it would, therefore, be unnecessary to repeat; however, I may observe that I was enabled to satisfy myself of two facts, namely, that of the total absence of anything like a nucleus, or even of granular matter, of any description whatever, in many of the minute branches, these being composed entirely of clear, wavy filaments;* and of the fact of an entire absence of nerve tubules, in by far the majority of the most minute branches.†

From the foregoing observations, it appears that although the characters of the sympathetic, whether connected with the arachnoid, or found in structures confessedly ganglionic, are in some branches sufficiently characteristic, yet that in others, these fibres resemble so much simple cellular or elastic fibre, as not to be distinguishable from it by any single microscopic character. To determine, then, the nature and office of filaments of this description, it will be necessary to consider, in conjunction with their microscopic appearances, their general characters, more especially their form and mode of division, and their relations, as well anatomical as physio-

* By an inexperienced observer, the particles of oil which become mixed with the filaments of the nerves whilst dissecting them out from the surrounding adipose tissue, may be mistaken for nuclei, or granular matter.

† This last fact is important, inasmuch as it goes to disprove the opinion entertained by some physiologists, that the sympathetic is not, in itself, a distinct nerve, but is made up, in all cases, of cerebro-spinal nerve tubules, and organic fibres.

logical, to other parts. Now, combining all these considerations, and observing that, as the filaments which go from the sympathetic plexuses to the vessels of the viscera, resemble so much those going from the arachnoid to the cerebral vessels, that no difference between them is distinguishable by the microscope, either in their structure or their mode of distribution to the vessels, there is the strongest rational evidence in favour of their office also being the same; and as they spring from the arachnoid and go to the cerebral vessels, that the arachnoid is as much a source of organic nerves (*nervi vasorum*), as are the plexuses from which filaments go to the vessels of the kidney, or other viscera.

Thus far my observations have been confined to the structure of the fibres of the arachnoid, and their supposed use. I will now consider the corpuscular, or ganglionic part of this membrane. Some of the plexuses on its cerebral surface have the interstices, formed by their interlacing fibres, completely filled up with small roundish corpuscles, about the size of blood-discs; whilst, in others, these fibres are covered with irregularly-oval masses of them. On this surface also, in various situations, there are well-defined round or oval bodies, having in their centre a granular nucleus surrounded by fibrous tissue, intermixed with more or less corpuscular matter. Some of these bodies are connected to the fibres of the arachnoid by a very fine thread, others are situated at the conflux of two or more fibrous chords (see Plate II. figs. 6 and 9), and their diameter varies from that of two to seven blood-corpuscles. They are generally solitary, and not numerous; but as they have been present in the arachnoid of every human subject which I have examined, (a number exceeding twenty,) they cannot be regarded as accidental or adventitious. At present I cannot decide as to their nature or office, not having seen anything which they exactly resemble in other parts of the body; at any rate, they look more like small ganglia than anything else I have seen.

Besides these corpuscles, which, as before stated, exist on

the cerebral surface of the arachnoid, I have met with some of a very different character, situated in its substance, though nearer to the cranial than to the cerebral surface. The most ordinary appearance which these present, when seen by transmitted light, is that of a section of an urinary calculus made through its centre, appearing, like it, to be made up of concentric layers. When viewed by reflected light, these bodies seem to be vesicular, and filled with fluid, the quantity of which appears to diminish as the number of layers increases, so that those in which the laminæ have extended as far as the centre, are almost flat. Although the most frequent form of these bodies is circular, yet some are oval; occasionally they are connected with a fibre of the arachnoid, in such a manner as to resemble small Pascinian corpuscles. One remarkable fact connected with these bodies is, that they occur in the arachnoid of almost every subject which I have had an opportunity of examining, and that no part of the membrane is exempt from them; generally they are solitary, and very sparingly distributed; but sometimes they are in clusters. I have found them in the internal Pacchionian glands mixed with granular matter, and the same kind of fibre as exists in most parts of the arachnoid membrane. Their diameter varies from $\cdot75000$ to $\cdot39800$ of an inch. I have observed on some parts of the arachnoid, in the vicinity of a cluster of these bodies, cavities of a similar shape and size, from which the corpuscles themselves appeared to have been dislodged. From this circumstance, as well as from the general aspect of these bodies, they seem to me either to be structures altogether adventitious, or the result of an abnormal deposition in diseased corpuscles. The tendency which they may be observed to have to coalesce when several smaller ones occur together, evident by the obliteration of those portions which seem pressed against one another, and the union of the remote segments to form a single outline enclosing an area whose figure clearly indicates the number of corpuscles which have united to form it, proves them to be something more than mere earthy de-

posits, such as are sometimes found in the choroid plexuses, or even than mere scrofulous tubercles.—(See Plate III. fig. 4.) Vogel has found bodies similar to these in the choroid plexuses; in these, and in the pia mater, Dr. E. Harless has also seen them, and given a very minute account of their structure, in a number of Müller's Archives, 1845. This author seems to think that their seat is in the arteries, and that they are somewhat allied to ossification of these structures; but their occurrence in all parts of the arachnoid, in some of which there are probably no vessels, is opposed to this view.

The organs connected with the arachnoid, which to me seem to correspond in their structure, and therefore in their function, to the ganglionic corpuscles of the sympathetic, are the globular bodies which cover the villi of the choroid plexuses. Before considering their minute structure, I will make a few observations upon their general connections.

The choroid plexuses are generally admitted to be portions of the membranes of the brain. They are situated in the lateral and fourth ventricles, and a considerable portion is placed upon the external surface of the cerebellum against the inferior vermiform processes. They are composed of the terminal loopings of the cerebral vessels, which are accompanied by chords going from the arachnoid membrane, some of which are more or less intimately connected with the coats of the vessels, others merely accompanying them to their ultimate villi, and appear to become lost in the membrane covering the vessels. These chords also accompany the individual vessels going from the choroid plexuses to different parts of the internal surface of the ventricles. The surface of the choroid plexuses, both within the cavities and on the external surface of the brain, is covered by a layer of globular bodies, each of which has a diameter nearly equal to two blood-corpuscles. In the sheep they are rather larger than in man. This layer of corpuscles is generally considered as a species of tessellated epithelium, and as such is represented by Valentin in his plates, each corpuscle being represented as an hexagonal

flat scale, with a round nucleated cell in its centre.—(See Plate III. figs. 2 and 3.)

To show the inaccuracy of this idea, and to observe the true structure of these bodies, the free edge and adjoining surface of a villus of the choroid plexus ought to be examined, without being in the least compressed, with a lens of one-eighth of an inch focal distance, and the decided convexity of the free margin and surface of each corpuscle will show that its form is spherical and not flat, and that it is a vesicular body, and not an epithelial scale. The contiguous portions of the vesicles, remote from the free margin of a villus, being pressed together, will be somewhat flattened, and those which are thus compressed on all sides, rendered polyhedral; but, if some of them be detached and isolated from one another, their circular figure will be more or less restored. As these corpuscles contain very fine molecular matter, whose colour is deepened by the action of weak spirit, their true form may be best seen in those which have been kept for some days in this fluid. If a villus, thus prepared, be viewed by the microscope, the line of separation between one vesicle and another, instead of appearing to be rectilinear, and situated between two flat surfaces, as in a tessellated epithelium, will be observed to be curved, and placed at the bottom of a groove formed by the meeting of two dark grey convex surfaces.—(See Plate III. figs. 2 and 3.) Besides the molecular matter contained in these vesicles, there is also in each a distinct eccentric nucleus, which, when freed completely of all adherent matter, looks clear and well defined; it has generally within it one or two nucleoli. The nuclei are best seen when the part is perfectly fresh, as the contents of the vesicles, when darkened by spirit, or from any other cause, make them appear indistinct; and that part of the plexus choroides which is situated external to the fourth ventricle upon the vermiform process of the cerebellum serves best for this purpose. As respects the ciliary motion, discovered by Purkinje, on the lining membrane of the ventricles of the brain, and the vesicular bodies upon the plexus choroides, I may notice that I have looked for it on

EXPLANATION OF THE PLATES.

PLATE II.

- Fig. 1.—Shows a portion of the sympathetic nerve from the mesenteric plexus of a woman.
- Fig. 2.—A branch of the sympathetic nerve of the snake.
- Fig. 3.—A portion of one of the chords connecting the arachnoid with the cerebral vessels.
- Fig. 4.—The mode of division, and ramification of the arachnoid, in the arachnoid membrane.
- Fig. 5.—A triangular gangliiform body situated at the conflux of three arachnoid chords.
- Fig. 6.—Some of the corpuscles connected with a plexus of the arachnoid.
- Figs. 7 and 8.—Expansions in which the arachnoid chords terminate in the arachnoid of the cauda equina.
- Fig. 9.—One of the corpuscles situated at the conflux of three chords.
- Fig. 10.—Some of the nucleated fibres in the chords of the arachnoid.

PLATE III.

- Fig. 1.—Shows a chord connecting the cerebral surface of the arachnoid, with a cerebral vessel.
- Fig. 2.—The corpuscles on the free edge of a villus of the choroid plexus.
- Fig. 3.—A portion of tessellated epithelium.
- Fig. 4.—Some of the concentric bodies situated in the arachnoid.
- Fig. 5.—A chord connecting the cerebral surface of the arachnoid, with a cerebro-spinal nerve.
- Fig. 6.—The disposition of the fibres forming the plexuses on the inferior surface of the arachnoid.

the latter, without seeing it. If, however, there be ciliary motion upon these vesicles, it ought not to be confined to the ventricles of the brain, since some portion of these plexuses are situated also on its exterior. Now, on comparing the corpuscles attached to the choroid plexuses with those of the grey matter of the brain and the ganglia of the sympathetic, I found a very striking resemblance, especially with the latter. In their essential characters, there is an agreement as close as exists between identical structures in different subjects, or in different parts of the same subject, the corpuscles in all these cases being characterized by a delicate transparent membrane filled with very fine molecular matter, and containing an eccentric nucleus, having generally a nucleolus or nucleoli. From this resemblance in their structure it seems to me not improbable that there may be something in common in their function. The only theory which can be put in opposition to this is, that the plexus choroides may possibly serve for the secretion or absorption of fluids. (See Dr. Todd on the Nervous Centres, *Cyclopædia of Anatomy, &c.*) Had this been the case, one would have expected to find some character common to all the parts with which these plexuses are in contact, indicative of one common office;—either there would be something provided to receive the fluid they give out, or to supply them with that which they are required to take in; now, as the dissimilar character of the many and various parts with which these organs are connected indicates the existence of no such provision, this theory seems to be without support.

I may here observe that I do not imagine every part of the arachnoid to be nervous, but that this property exists in those which are made up of soft corpuscular matter, and the ramifications of the chords going to the arteries and nerves. The adjacent surfaces of the arachnoid and dura mater are covered in parts with tessellated epithelium; and, in some situations, these membranes are continuous one with another; but the entire thickness of the former does not line the cerebral surface of the latter: the stellate and ramifying fibres of

which the inferior surface of the arachnoid is, in a great measure, composed, being continued upon the vessels of the pia mater, render such a mode of connection between these membranes impossible. The arachnoid is unlike other serous membranes, in having, in different situations, characters altogether dissimilar—in some being thin, soft, transparent, and granular; in others, thick, strong, opaque, and fibrous (these differences in many cases not being explicable upon mere mechanical grounds): also in its relation to other parts, the visceral portion of the arachnoid, instead of being closely connected with the part it invests, and thus having but one surface free, like the pleura, &c., is separated from it by the intervention of other structures, for instance, by the pia mater, by fibrous chords and plexuses, and, in some situations, by a quantity of fluid, and, consequently, it has two free surfaces; this is especially the case at the base of the brain. It appears also to possess a higher state of sensibility and a more direct and extensive connection with the cerebro-spinal nerves than other serous membranes, as shown by an experiment performed by Mr. Henry Smith, and related by Dr. Marshall Hall, in which, after the removal of the brain from a dog, the arachnoid, lying loose at the bottom of the cranium, about the medulla oblongata, was pinched, and convulsions of the face and other parts of the body were instantly produced. (See Medical Times, vol ii. p. 294.)

The arachnoid, besides being continuous with the dura mater by its epithelial layer, is also connected with it by fine threads, some of which appear knotted, and others tubular. The external surface of the spinal arachnoid, especially at the posterior part of the *theca vertebralis*, is also attached here and there to the dura mater by similar threads, some of which are connected by both their extremities to this membrane, whilst the middle part is enclosed in a tubular process of the arachnoid. These threads are altogether distinct from the ligamentum denticulatum.

The middle septum, extending from the posterior part of the pia mater to the arachnoid, contains ramifying fibres,

which go from the latter to vessels situated behind the pia mater, between it and the arachnoid, and, also, to the vessels of the pia mater itself.

As respects the supply of vessels and cerebro-spinal nerves to the arachnoid, I may observe, that the arteries are few, but rather large, almost sufficiently so to receive a small injection tube; (I have preparations of these;) and that cerebro-spinal nerves may be traced into its visceral portion, and, with the microscope, their tubules can be seen running along with the arachnoid fibres, into which they appear, from the gradual loss of their tubular contents, to degenerate.

The soft texture and expanded form of the arachnoid may, at first sight, appear at variance with the notion of its being nervous; such, however, is the common appearance presented by the sympathetic in other parts of the body. Upon this subject, Mr. Swan, whose splendid work upon the nerves is well known to anatomists, observes, that "many are apt to be too much guided by notions they have early imbibed respecting the form, substance, &c., of various parts of the body, and cannot at first reconcile it to themselves, with regard to the nerves, that anything in the form of a thin membrane can perform the function of a round, thick, rope-like substance." (Swan on the Nerves, p. 35.)

And just as nerves pass from these expansions to the mesenteric and renal arteries, so do they pass from the arachnoid to the arteries of the brain. Indeed, if the brain received no other organic nerves than those which it derives from the ganglia in the neck, it seems to me that its supply of these nerves, compared with that which other organs receive, would bear no proportion to the very large quantity of blood which circulates through it, and to the activity of the function which it performs.

According to this inference, it might be expected also that the distribution of the sympathetic to the extremities would be more general than anatomists are disposed to admit. However, upon this subject there is great diversity of opinion, some anatomists regarding structures as sympathetic nerve,

which, by others, are said to be *merely* cellular membrane. Mr. Swan describes and depicts branches going from the nerves of the extremities to the vessels, ligaments, and bones. One of these branches he describes as follows:—"The continuation of the spiral underneath the anular ligament forms a gangliiform enlargement upon the capsular ligament of the wrist, which gives off small branches to be distributed on the capsular ligaments and the tendinous sheaths at the back of the wrist." (Page 28, Plate XXIII.) Since then, all the nerves going to the joints have been described as being of a grey colour, and having upon them gangliiform enlargements. Now, in addition to these anatomical facts, the circumstance of these nerves supplying parts which are as much organs of secretion as the glands in the abdomen, would lead one to believe that they really are sympathetic nerves. I have examined some of those filaments, and found them to be composed chiefly of yellowish fibres.

Remak, in reference to the nerves of the skin, observes, that they are accompanied by delicate fibrils, which they quit when the nerves proceed to form their terminal plexuses, the fibrils being then seen to form a net-work in their meshes. To these fibres Gerber is disposed to attribute a vital function, thinking it possible that they may serve as subordinate means of conducting nervous influence. The secretion of the skin and kidneys are influenced, the one very much by the other; and if the latter require, for the performance of its functions, a distinct plexus of sympathetic nerves, why ought not the former? About two years ago, I observed that the nerves supplying the skin were so intimately connected with a large quantity of minute fibres as with difficulty to be separated from them, and that, in this respect, they differed from those nerves going to the muscles. This difference I proposed at that time to Mr. Grainger as a means of distinguishing nerves of sensation from nerves of motion. However, it does not exist with respect to the roots of the spinal nerves from the spinal marrow.

The following fact, noticed by Todd and Bowman, seems to

throw some light upon this subject. These authors observe, that, "in dissecting the connections between the sympathetic and the spinal nerves, we find that, for the most part, two distinct fascicles connect them, one of which is *white*, being composed of tubular fibres; the other is *grey*, and consists of gelatinous fibres."

Now it seems to me to be very probable that these grey fascicles are, in reality, the origins from the spinal ganglia of those portions of the sympathetic nerve which are to be distributed to the extremities, and that they attach themselves to the spinal nerves in this situation, as being most convenient; then accompany their divisions to the extremities, as the same system of nerves in the abdomen accompanies the arteries; and, lastly, that they run with the branches of these nerves, by which they are conducted to their destination. Those, for instance, which go to supply the secretory apparatus of the skin, run with the nerves of touch; hence it is for this reason that these nerves are so abundantly accompanied by grey filaments as above described; whilst those which go to the joints, for the secretion of synovia, accompany the nerves passing near to these parts for a certain distance, and then leave them to go to be distributed with the arteries secreting the synovia, as was observed of the branch of the spinal nerve noticed by Mr. Swan. The fascicles of tubular fibres, mentioned by these authors, probably proceed from the spinal nerves to the ganglia, and afterwards accompany their branches to the parts supplied *chiefly* from this system of nerves, to which is due that obtuse state of sensibility possessed by certain parts,—as, for instance, serous and fibrous membranes,—a sensibility, however, so low as only to be made perceptible, and the nervous connection of these parts with the brain rendered evident, by the pain which is referred to them when they are in a state of disease. It is rather strange that, in spite of such physiological proofs of the existence of nerves in these structures, physiologists are so much averse to admit parts entering into their composition, and having the general characters of nerves, to be such. If, in

a transparent sensitive membrane, as the arachnoid, which admits of being fully examined by the microscope, there are certain fibres disposed in the manner of a nerve, either these are in reality nerves, or the microscopist ought to be able to point out those structures in this membrane which are nerves. If he will not admit the one, and cannot do the other, then he *must* yield to the conclusion that all the *other* fibres, excepting these, which enter into its composition, nervous and not nervous, resemble one another so much, and are so similar in their appearance to cellular tissue, that those of them which perform a vital function (evident from the sensibility of the membrane) cannot be distinguished from those which perform a mechanical one, and therefore, that all the positive *anatomical* characters which distinguish nerves in their more perfect state of organization, are absent in those which enter into these structures, or, at least, that they cannot be recognized by the microscope. This consideration shows that if, in these cases, it is difficult to decide with certainty as to what is a nerve, it is quite as much so to say what is not one; and that the mode of disposing of the difficulty by calling almost every fibrous chord or membrane which has not in it a certain kind of nucleated fibre, "merely cellular tissue," is as erroneous as it is unphilosophical.