PHILOSOPHICAL

TRANSACTIONS.

I. *The Croonian Lecture. On the internal structure of the Human Brain, when examined in the microscope, as compared with that of Fishes, Insects and Worms. By Sir* EVERARD HOME, *Bart. V.P.R.S.*

Read November 20, 1823.

AT the time this Lecture was instituted for the discovery of the principle on which muscular motion depends, the principle was supposed to be inherent in the muscular fibre itself: the numerous dissertations, therefore, which are registered in the Philosophical Transactions, are in general so many investigations into the properties of muscular fibres.

This part of the subject may be considered as completely exhausted, although the principle on which the motion depends is not yet made out. This leads me to believe that we must extend our enquiries to the structure of the brain and nerves before we can arrive at it.

It is now, I trust, universally allowed by physiologists, that muscular motion cannot take place in living animals without the aid of the medullary structure of which the brain and nerves are composed.

Every enquiry into the more minute parts of the brain and nerves, as well as their ganglions, must be carried on upon the field of the microscope, and Mr. BAUER, in consequence of the many valuable discoveries which have been made by his skilful use of that instrument, has too much zeal for science to withdraw himself from such pursuits.

Considerable advance has been already made in this enquiry by Mr. BAUER's observations on the component parts of the blood, the formation of the embryo of the chick, and the component parts of the brain.

These observations are registered in the Philosophical Transactions, and the communications have been of so recent a date, as not to require that I should do more in this place than refer to them.

In the present Lecture, it is intended to pursue still farther the anatomy of the human brain, and to compare it with that of fishes, insects and worms; in the hope that by the establishment of such a series of facts, we may throw light on the connection between the action of the nerves and the motion of the muscles.

The following circumstances explain the difficulties that are met with in the examination of the structure of the human brain.

The transparent elastic matter readily dissolves in water, and when in solution the globules become one confused mass.

The cortical substance containing serum, when it coagulates, is different in density from the medullary structure, and readily separates from it; the serum also in drying cracks into regular figures, giving it an appearance of a net work which is artificial.

The globules and elastic substance being in different proportions in different parts of the brain, have an influence upon the appearance put on by the coagulum, which is a source of deception, and makes the coagulum tear more readily in some directions than others, as if fibres in those directions existed, which is not the case.

The parts not being of one uniform density, makes it impossible for the sharpest knife to cut evenly; some of the globules must therefore be displaced, while others are not.

When the brain is immersed in alcohol and rendered solid, all these deviations from the natural appearance must be encreased in a greater degree, since the elastic substance is rendered opaque by coagulation, and all appearance of globules lost.

To obviate these sources of error, I requested Mr. Bauer to examine a small portion of the human brain in a recent state, composed of cortical and medullary structure, which had been immersed in distilled water: the surface of the elastic substance it is true, was dissolved, but what remained completely preserved its transparency; the appearance the surface put on when magnified twenty-five times, is seen in the annexed drawing, rows of globules from the circumference of the cortical substance are passing unbroken in straight lines into the substance of the medullary portion, which could not have been detected in any other mode of investigation.

I shall not prosecute farther this part of my subject on the present occasion, but proceed to the consideration of the brain of fishes, (that of quadrupeds and birds being in its structure so similar to the human brain, as not to require any notice of its peculiarities to be taken).

In the representation of the brain of the Tench, which is annexed, there is evidently a smaller quantity both of medullary and cortical substance in proportion to the size of the animal than in the bird, and its form is less compact, being made up of spherical nodules, medullary on the surface, and internally cortical: the basis of the brain is also nodulated, and in the centre is an oval cavity. The nodules are upon so small a scale that their internal cavities are not to be distinguished, but in the squalus maximus they are very conspicuous. I am now to point out the peculiarities of the brain in insects and worms; but cannot tread upon the same ground on which Swammerdam has preceded me, without paying a tribute of praise to that great man, who, labouring under such disadvantages as he must have done, in the age in which he lived, has performed so much, and in many instances has left nothing for those who follow him, but to bear testimony to the correctness of his representations and judgement.

There are some points in which he gave way to public opinion, and did not disbelieve what every one said must be true. I allude to his attempt to represent the eye of the garden snail at the point of the horn, which does not exist. He found black retemucosum, which he mistook for nigrum pigmentum, and a pellucid part which he took for cornea. To show this fallacy, I have annexed Mr. Bauer's representation of these parts. Swammerdam has given a faithful representation of the nerve, which might have undeceived him, it having no resemblance to other optic nerves, but being like those commonly met with going to tentacula.

It is curious, that long as has been the intervening period of time between Swammerdam and Bauer, no one has arrived at a like excellence in the use of the microscope; for certainly POLI (however splendid his plates) cannot be put in competition with either of them.

When SWAMMERDAM died, and no one found himself equal to succeed him, a report was raised that his microscope was of a peculiar kind, and the mode of using it was lost at his death; so it is now with BAUER. Many applications are made to the mathematical instrument makers for a BAUER's microscope, by those who are not willing to believe it is their inability, and not the fault in the microscope, that prevents their arriving at his excellence.

In all the insect tribe I have examined, the brain is formed upon the same general principle, but very different from that of fishes; the brain is in one mass; it is too small to admit of a particular description, but contains globules; and from the readiness with which it dissolves upon exposure, there is no doubt of there being a fluid contained in it. Besides this, which is admitted to be the brain of the insect, there is another substance connected to it by means of two chords. This second part has been, I believe, usually called the first ganglion, but, when accurately examined, it is similar in its texture to the brain: the two chords which unite them are not properly nerves, since they are upon their first exposure turgid, but soon collapse. These two substances with their uniting chords form a circle, and surround the œsophagus; from the upper mass go off the optic nerves, those to the tentacula, tongue, &c.

From the lower mass go off the nerves to the upper extremities.

I shall therefore consider the upper as the brain, the lower as the medulla spinalis.

Below this is a regular line of ganglions, properly so called, being made up of a congeries of nerves, as the ganglions in the human body are now admitted to be.

The brain appears to be made up of two lobes. The mass I call medulla spinalis, is also made up of two portions, united together by the two lateral chords.

The ganglions down the body of the animal are united together by a double nerve.

The annexed drawings show this structure better than can be explained by verbal description. Among the insect tribe the brain of the Humble Bee stands first, as being largest in proportion to the size of the body of the insect. Swammerdam has given a representation of the Bee; it is in general correct, but not so in respect to the optic nerves.

The Moth and Caterpillar have the same kind of brain, medulla spinalis, and series of ganglions, as in the Bee: the parts in the Caterpillar are nearly of the same size as in the Moth, but in both they are smaller than in the Bee. Swammerdam has given a correct representation of these parts in the Caterpillar of the Silk-worm, but none of the Moth.

The Lobster is similar in the structure of all these parts to the Bee, and although they are smaller in proportion to the size of the animal, they are still so large as to be readily seen, and explain what is not so distinct in the smaller insects.

The Earth-worm has a brain and nerves formed upon a smaller scale, but made up of the same parts.

In the Garden Snail, the brain and medulla spinalis are upon the whole larger in proportion to the size of the animal than in the Bee; but in this animal, there are no ganglions, which may account for those parts being so large.

The clear and distinct representations which Mr. BAUER has given of these very minute objects, has made it unnecessary for me to take up the time of the Society in giving detailed descriptions of the different parts; indeed any thing that is to be said, had better be stated in the explanation of the drawings, than connected with the general remarks which form the Lecture itself.

The Snail having a brain of the same kind as the Bee, and the medulla spinalis having a similar structure, while the series of ganglions is wholly wanting, forms one of the most curious parts of this investigation. Having ascertained that, in all the animals, the structure of whose nervous system has been explained in the present Lecture, the brain is a distinct organ, varying in size it is true, till at last it is scarcely distinctly visible to the naked eye, but when examined in the microscope, found to consist of globules and elastic transparent matter, and more or less of a fluid, similar to the brain of animals of the higher orders; that there is also at some distance from the brain, a second substance of similar structure, connected with the brain by two lateral chords; and that this second part gives off the nerves that go to the different muscular structures of the body; I consider myself borne out in the opinion that this part answers the same purpose as the medulla spinalis.

The ganglions which form a chain connected so beautifully together by a double nerve, must be considered to have the same uses, whatever they are, as the ganglions in the human body, being equally composed of a congeries of nerves. These are facts, which if they are allowed to be clearly made out, form an addition to our knowledge, and give confirmation to opinions not before satisfactorily established.

Here I shall conclude the present Lecture, neither Mr. BAUER's time nor my own having admitted of our proceeding farther in this curious and interesting anatomical investigation, which I am not without hope, in the course of another year, of our rendering as complete as microscopical observations admit of, by examining the nervous system of a class of animals in which the existence of a brain has not been ascertained.

Till that is done, I must postpone any physiological remarks connected with the subject, all the facts belonging to it not having been determined.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. A small portion of the human cerebrum in a recent state, which had been immersed in distilled water; magnified five diameters.

Fig. 2. A smaller portion, magnified twenty-five diameters; showing the arrangement of the globules, in straight lines, which pass uninterruptedly across the cortical substance into the medullary.

Fig. 3. A still smaller portion, magnified two hundred diameters, by which means the globules are rendered conspicuous.

Fig. 4. The brain of a tench, of the natural size. The cranium is removed, and the upper surface of the brain exposed to view.

Fig. 5. The under surface of the same brain.

Fig. 6. A horizontal section of the same brain; showing that the nodules have a cortical substance internally, and a medullary on the outer part.

Fig. 7. The cavity in the tench's brain.

Fig. 8. The brain and nerves of the humble bee; magnified ten diameters.

The brain is of a truncated oval form; it gives off the nerves to the eyes and feelers; its internal structure made up of globules. The substance, corresponding in its uses to that of the medulla spinalis, is nodulated on its external surface, connected to the brain by two long chords, which differ from nerves in collapsing soon after being exposed; these I shall call crura cerebri: the lower portion of this nodulated structure corresponds to the medulla spinalis, and, in its internal structure, resembles the brain.

The two nerves that go down, connected at certain distances by small nodules, are different from nerves in being more pulpy, and the nodules themselves are composed of congeries of nerves, similar to the ganglions in the human body, of which there are many excellent representations before the public, which makes it unnecessary to show their structure upon this occasion.

Fig. 9. The brain and nerves of the garden snail; magnified four diameters.

In this animal the brain is made up of two apparently equal portions. As the appearance at the termination of the two large horns resembles eyes, and Swammerdam has attempted to delineate the different parts of the organs: Mr. Bauer has shown the two nerves in different states.

The medulla spinalis forms a larger mass than the brain, but equally made up of two distinct parts. From the upper edge of this mass, there is an azagos branch going directly upward to the muscles of the tongue, beyond which are the glands of the mouth, and the œsophagus cut through.

This nerve, so similar to the recurrent in the human body, only differing in being single, justifies me in having given the name of spinal marrow to the part that gives it off.

Fig. 10. The point of one of the large horns, magnified fifty diameters; to show that the external point of its termination in no respect resembles a cornea, but consists of five bundles of nervous filaments, the terminations of the branches of the nerve.

PLATE II.

Fig. 1. The brain, spinal marrow, ganglions, and nerves of the moth of the silk-worm; magnified ten diameters.

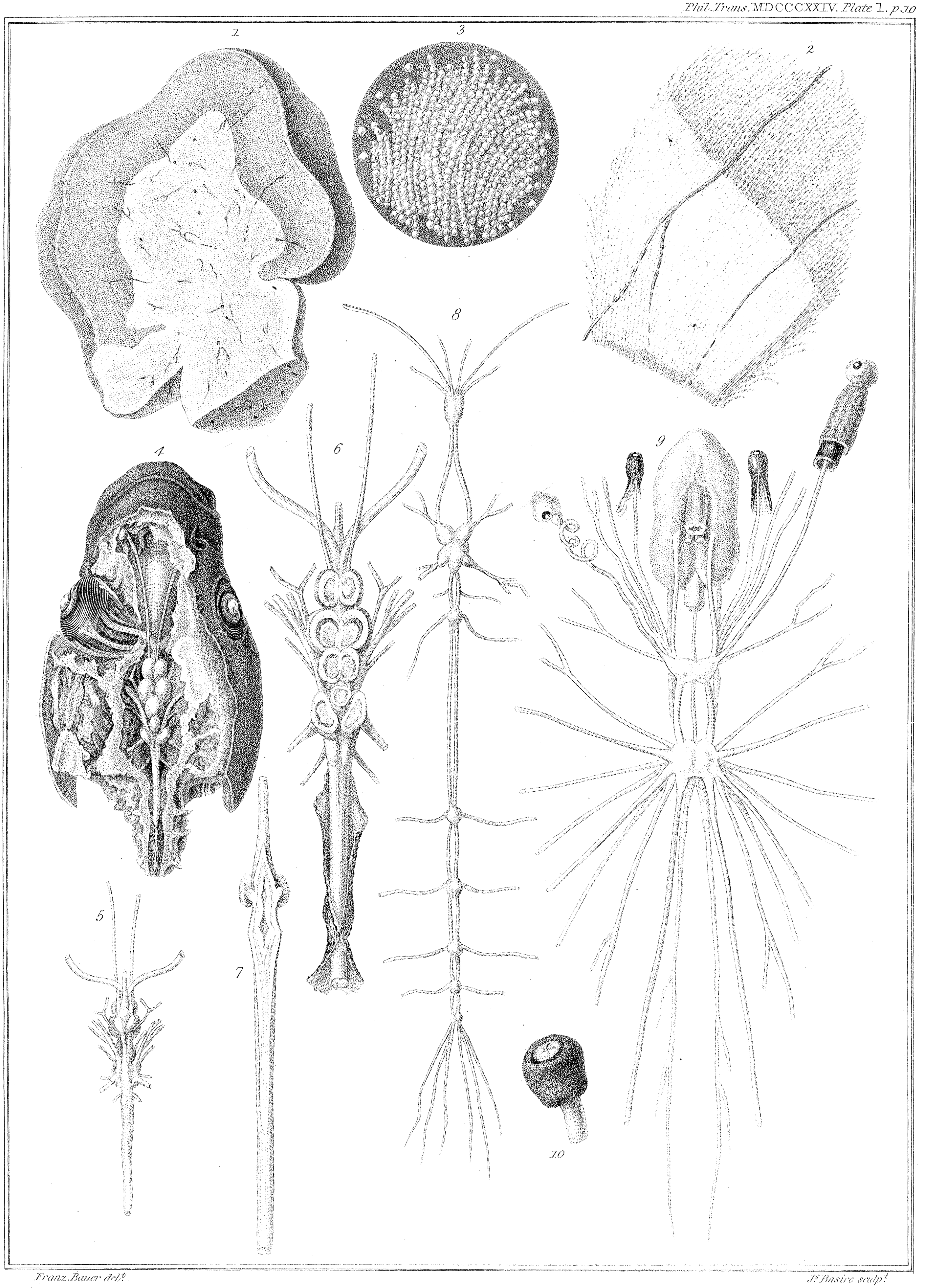
Fig. 2. The same parts in a large caterpillar; magnified four diameters.

Fig. 3. The same parts in the lobster; natural size.

Fig. 4. The same parts in the earth worm; magnified two diameters.

Fig. 5. The upper part of the same earth worm; magnified eight diameters.

In Fig. 1, 2, 4, and 5, the ganglions, as well as the brain and spinal marrow, are upon too small a scale to admit of accurate examination, but in a large lobster, the distinction I have made between the brain and spinal marrow and the ganglions, was satisfactorily confirmed, and even in the earth worm it was sufficiently distinct.



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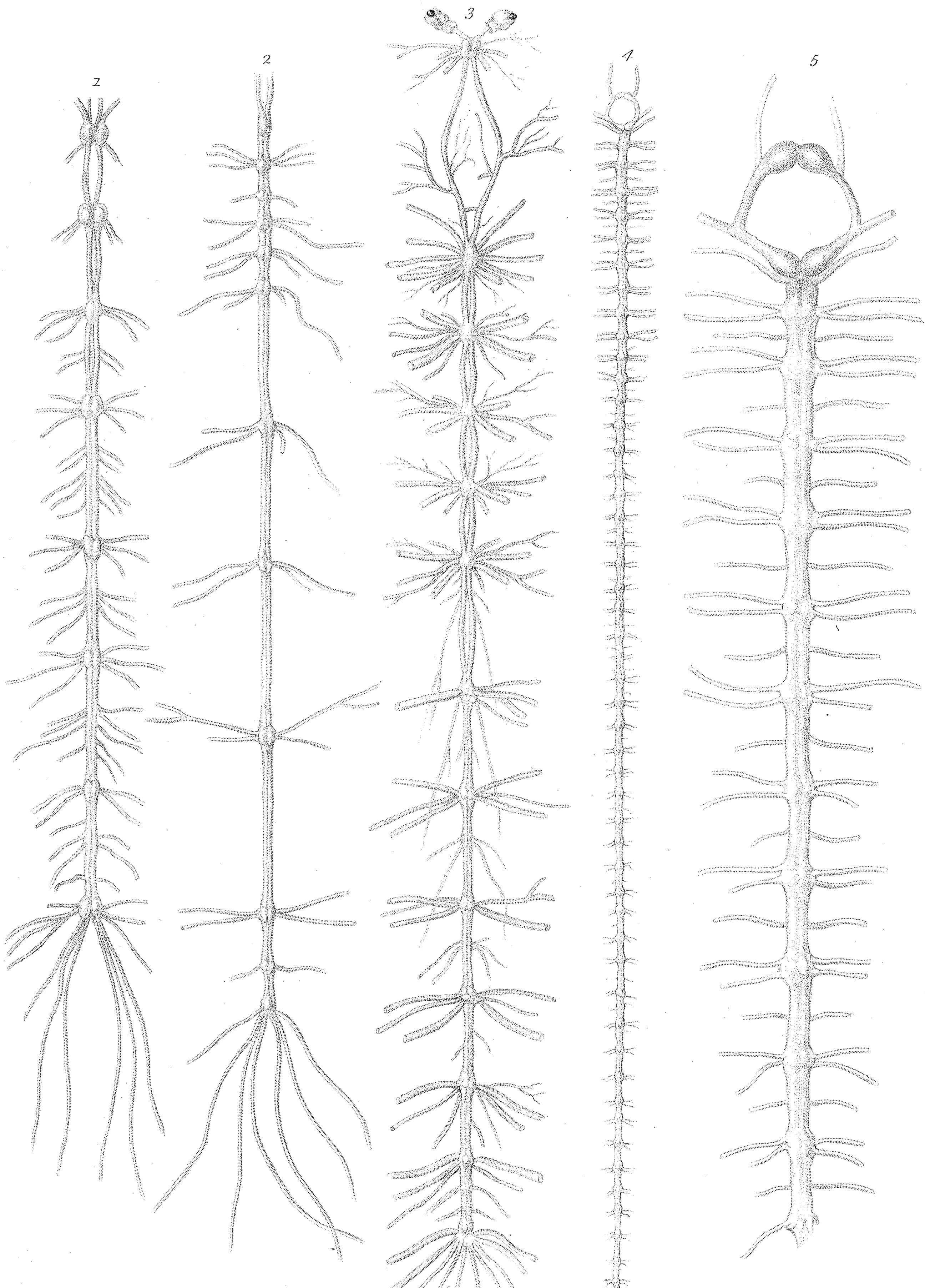

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