Prof. A. Weismann
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REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF
Captain GEORGE S. NARES, R.N., F.R.S.
AND THE LATE
Captain FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF
THE LATE
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DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD
AND NOW OF
JOHN MURRAY
ONE OF THE NATURALISTS OF THE EXPEDITION

ZOOLOGY—VOL. XIX.

PART LIV.—REPORT ON THE NEMERTEA

By Dr. A. A. W. HUBRECHT, LL.D., C.M.Z.S.

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EDITORIAL NOTE.

On the return of the Expedition the specimens of Nemertea, along with the Annelida, were placed in the hands of Professor W. C. M'Intosh, F.R.S., for description. In the year 1884, however, Professor M'Intosh's time being fully occupied with the Annelida, Professor A. A. W. Hubrecht of the University of Utrecht, was requested to undertake the investigation and description of the Nemertea, and the results of his labours are presented in this interesting and valuable Report.

The Manuscript was received by me in instalments between the 12th October and 18th November 1886

John Murray.

Challenger Office, 32 Queen Street,
Edinburgh, *9th February* 1887.

THE
VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the Nemertea collected by H.M.S. Challenger during the Years 1873-76. By Dr. A. A. W. Hubrecht, LL.D., C.M.Z.S., Professor of Zoology and Comparative Anatomy in the University of Utrecht.

INTRODUCTION.

It was in September 1884 that the collection of the Challenger Nemertea was handed over to me for investigation, on the express condition that the whole of the MS. and plates were to be ready within fifteen months.

I mention this, not only with a view of finding an excuse for omissions and curtailings which cannot fail to have been occasioned in this Report by its rather rapid elaboration, but at the same time in order to be able at the earliest moment to express my thanks to Professor W. C. M'Intosh of St. Andrews, in whose hands the Nemertea were placed on the return of the Expedition, for his suggestion that the working up of this group should be entrusted to me, his own time being fully occupied with the description of the Annelida of the Expedition.

He moreover placed at my disposal such notes as he had already found occasion to make upon the contents of the collection, some of them referring to species which he recognised as new to science. When in the following Report these notes are made use of, such passages will be specially indicated.

The material, as it was put into my hands, was contained in about thirty small bottles, and was without exception preserved in spirit. It looked far from promising from a systematist's point of view. Hardly any traces of coloration were visible, no external appendages distinguished the different species, no definite shape, marked out by hard portions of the integument, which facilitate the recognition of representatives of so many other divisions of the animal kingdom, were anywhere noticeable.

The majority of the specimens in the collection were cylindrical or flattened fragments, generally truncated, and rarely so intact that it was possible at first sight to distinguish between head and tail. The cephalic slits of those specimens which belong to the group of the Schizonemertea, and the mouths of many of the fragments, were the only external marks that could serve both for the discernment of what was posterior and anterior, and for a rough and provisional arrangement of the forms as they were probably related to each other.

The various figures on Pl. I. will give a general impression of the appearance of the fragments just alluded to. I more especially insist upon the poor aspect presented by the preserved material of the Nemertea in order to impress the reader with the fallacy of pronouncing an unfavourable judgment on a collection of marine invertebrates by relying merely upon the external appearance of the specimens. For I can hardly sufficiently emphasise the exceedingly good state of preservation of the large majority of the Challenger Nemertea. They were, indeed, in so perfect a state that the internal anatomy of all the fragments could be determined, and in very many cases delicate histological details could be revealed with as much facility as if the specimens had been captured a few days instead of ten years ago. I feel the more called upon to make this statement, and to express my admiration for the extreme care which the scientific staff have so evidently given even to unattractive and small-sized fragments, as it has been occasionally stated (even in certain of these Reports) that the Challenger material was sometimes unfit for the minute investigation of internal anatomical structures. So far as the collection of Nemertea is concerned, this statement is absolutely unfounded.

The study of the fragments and complete worms constituting this collection was only possible by aid of the microtome. This instrument was very freely made use of, and the most important improvement to which it has been subjected by Caldwell, whose automatic microtome was available, has enabled me to go into many more details than would otherwise have been possible. The total number of sections through different specimens of the Challenger material which have been prepared in the drawing up of this Report amounts to 19,560. They were all of them stained with Ranvier's picrocarmine.

As already mentioned in the Narrative of the Voyage,[1] the number of Stations from which the Challenger obtained Nemertea is more than twenty. It cannot be said that any of the three large subdivisions of the group is limited to any special region of the globe, although representatives of the very lowest and most primitive genera of Palæo-

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[1] Narr. Chall. Exp., vol. i. pt. ii. p. 831, 1885.

nemertea are as yet only on record from the Atlantic and the Mediterranean. It is, however, very probable that these genera (the Carinellidæ) are cosmopolitan, and have as yet only escaped detection because even in the region from which they are known they count among the rare forms.

I have here only to add that in drawing up the list of the Challenger Nemertea, I will follow the subdivision into larger groups that was proposed by myself several years ago (**VII.**, p. 204),[1] and will successively treat of the Palæonemertea, Hoplonemertea, and Schizonemertea. It may be remarked that in the first named group, which contains the most primitive and least differentiated representatives, the genera *Valencinia* and *Eupolia* (=*Polia*) were also provisionally placed. These two may be looked upon as, to a certain degree, transitional forms. New light has been thrown by the Challenger material upon at least one of these genera, and it appears advisable to let them stand in that subdivision, however far they may differ in certain respects from the typical Palæonemertea, such as *Carinella*, *Carinoma*, *Carinina*, &c., and however strong their affinities may be in other respects either to the Schizonemertea or to the Hoplonemertea.

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[1] The heavy numerals refer to the Bibliography at the end of the Report.

DESCRIPTION OF THE GENERA AND SPECIES.

NEMERTEA.

A. PALÆONEMERTEA.

Family CARINELLIDÆ.

Carinina, n. gen.

Closely allied to Carinella, from which it differs in the presence of a distinct posterior brain lobe, situated with the rest of the brain and nerve-stems in the integument, outside of the body musculature. A ciliated canal penetrates into this posterior brain lobe.

Carinina grata, n. sp. (Pl. I. figs. 1–3; Pls. II., III., IV.; Pl. VI. figs. 1–3; Pl. XI. figs. 1, 2).

Two specimens of this new genus and species were obtained in the dredge, both from considerable depths, and from the same part of the Atlantic Ocean, namely, to the east of the United States (Stations 45, 47). The bottom is recorded to be blue mud, and the depth 1240 and 1340 fathoms respectively. This is the greatest depth from which Nemertea have been brought to light, and it is worthy of notice that this deep-sea form, which is at the same time the representative of a new and distinct genus, should be characterised by peculiarities of structure, hereafter to be more fully recorded, which are diametrically opposite to certain of the most striking features of the pelagic genus *Pelagonemertes* and of other forms that generally occur close to the surface. The most striking of these characters is the exceptionally strong development of muscular tissue in the body-wall, and coincident with this, the considerable reduction of the intermuscular connective tissue, which in the surface forms becomes a gelatinous matrix in which both the internal organs and the musculature are embedded.

It can hardly be doubted that this opposite line of development is to a large extent influenced by the much more considerable resistance to be overcome by an animal that has to move about at so great a depth of water.

Of the external appearance of the fragments of this new species little need be said.

They are reproduced both in the Narrative of the Cruise (vol. i. pt. ii. p. 831) and on Pl. I. figs. 1–3. There is no trace of longitudinal lateral slits—so characteristic of the Schizonemertea—but a terminal crescentic groove (marked out by darker pigment and by more profuse ciliation in one of the two specimens) was present in both. The proboscidian opening could be easily detected in both specimens, the subterminal mouth in one of them.

Incomplete as was the information that could be gathered from superficial examination, very interesting data came to light after the two specimens had been transferred to the microscopic slides. From specimen *a*, which was dredged at Station 45, a continuous series of transverse sections was made, whereas specimen *b*, from Station 47, was cut transversely along the region behind the brain, nearly horizontally through the brain and tip of the snout, and longitudinally through that region of the body where the nephridia are found.

It is very striking that in all these sections the cellular integument is of a considerable thickness when compared with the muscular (Pl. II.; Pl. XI. figs. 1, 2). In it we may distinguish several strata successively characterised (Pl. IV. fig. 1) by an accumulation of nuclei, by profuse integumentary gland-cells, &c., which will be more fully described in another chapter of this Report.

Curiously enough the contents of the deeper glands have a well-marked green colour in the anterior portion of one of the body fragments of specimen *b*, whereas they are brownish-red in the posterior portion, the whole fragment having first been stained with picrocarmine.

A homogeneous basement-membrane separates the integument from the subjacent muscles. This membrane is more deeply stained than other portions of the intercellular substance and thus stands out very clearly.

In the outermost cellular layer, distinct unicellular, flask-shaped glands are present (Pl. IV. fig. 1), although they are not so numerous as in many Schizonemertea, These facts authorise us to look upon the integument of *Carinina* as similar in all its essential elements to that of other Nemertea. We will further insist upon this similarity when describing *Eupolia* and *Cerebratulus*.

Before we pass from the integument to the muscular investment of the body we have to mention the central nervous system, which is found outside the homogeneous basement layer just referred to. Where the tissue of brain and nerve-stems takes its course in the deeper layers of the integument, it is directly applied against the subjacent muscles, the basement-membrane being indistinct if not interrupted beneath these central parts of the nervous system (Pl. III. fig. 7).

In addition to the two lateral stems, each transverse section reveals the presence of a dorso-median thinner nerve-stem, corresponding to what I have formerly termed the proboscidian sheath-nerve.

There is, moreover, positive evidence as to the presence of a delicate nervous plexus, situated just outside of the basement membrane already alluded to, and which, judging from the available fragments, is present throughout the whole length of the animal. The transverse sections also show that a second nervous plexus may be presumed to be present just outside the inner layer of circular muscles. The details of this will be discussed hereafter when considering the nervous system.

Passing forwards along the lateral nerve-stems we find them in every section fixed to the subjacent muscles by semicircular fibres indicated in figs. 7 and 8 on Pl. III. Anteriorly the stems pass insensibly into the brain, which, as a mere thickening of the lateral stems, has as yet only attained to a very low degree of differentiation. In this respect the brain much resembles that of *Carinella*, from which, however, it differs in a very important point, viz., the presence of a posterior lobe into which penetrates a ciliated duct ending blindly and communicating with the exterior.

This posterior lobe is situated, as is the anterior one, outside the muscles of the body-wall (Pl. VI. figs. 1–3), the inner channel is coated by a ciliated epithelium, differing in texture from the surrounding nerve-cells. The latter, however, can hardly be sharply distinguished from adjacent cells of a more indifferent character, and belonging to the lower strata of the integument.

The muscular elements partaking in the formation of the body-wall are kept distinctly apart from the tissue, which we have described as the integument, by the homogeneous membrane above mentioned. Below this membrane we find a thin, circular, muscular layer (Pl. XI. figs. 1, 2, β), then follows the much thicker layer of longitudinal fibres (α), and finally an inner layer, thinner again, of circular fibres (δ). The comparative thickness of these two latter layers throughout the œsophageal region may be gathered from Pl. II. fig. 5. In the two circular layers the fibres appear to be more closely set than in the longitudinal. In the outer circular layer the direction of all the fibres is, however, not perpendicular to the body-axis, a very regular network of other fibres which have their direction at an angle of 45° both with the longitudinal and the transverse axis, being closely interwoven with this layer. These are, however, not massive enough to form a distinct layer by themselves. The homogeneous intercellular substance, which is also present here between the bundles of muscular fibres, and which stains very distinctly with picro-carmine, is of course best visible when the bundles are widest apart. Such a portion is figured in Pl. III. fig. 6. This intercellular substance is also seen to be again traversed by radial fibres passing between the two circular layers; nuclei are, moreover, present both in the intercellular substance and enclosed along with the bundles of fibres.

Within the muscular body-wall are lodged—(1) the proboscis and its sheath; (2) the intestine; (3) the blood-spaces; (4) the nephridia; and (5) the generative sacs. The space not occupied by any of these is entirely filled up by a tissue, which I will call the gelatinous tissue, and regarding which more ample details will be given in the chapter dealing with the anatomy of the group. It is wholly continuous, and a body-cavity in which the above-named organs may be said to float, or to be suspended, is totally absent.

A rapid survey of the peculiarities which these five systems present must complete this descriptive account of the new genus. The aperture for the proboscis, which is situated terminally, leads into an anterior cylindrical compartment, which remains passive when the proboscis is protruded or retracted. It is coated by ciliated cells, and at the posterior end the anterior insertion of the proboscis into the body musculature takes place (Pl. II. fig. 8; Pl. III. fig. 5). Although the name is etymologically not wholly adapted for the purpose, I still am inclined to adopt for this compartment, which is present in all Nemertea, the name of rhynchodæum. This name as clearly separates it from the cavity of the proboscis or its sheath, as that of stomodæum and proctodæum distinguishes certain portions of the intestine of other invertebrates from the mid-gut.

The rhynchodæum of *Carinina* has a great resemblance to that of *Carinella*, more especially because of the wide and much distended blood-space which wholly surrounds it, and in which it is kept in place by numerous strings of tissue starting from the muscular body-wall and inserting themselves on the muscular investment of the rhynchodæum (Pl. III. fig. 5; *cf.* IX., pl. i. fig. 2). From the same figure it may be gathered that the internal cellular coating of the rhynchodæum is more than one row of cells thick, and that these cells have a clear and distended aspect, with a comparatively small nucleus.

The proboscis itself is inserted in a very simple way in the muscular tissue of the body-wall. The muscular investment of the proboscis curves round at an angle of 90°, and becomes continuous with the longitudinal muscular layer of the body-wall. The details of this arrangement may be gathered from Pl. III. fig. 5, and it will there also be seen how the protruded proboscis remains fixed to the body all along this annular point of attachment. Thence it extends backwards as far as the proboscidian sheath permits, which, in the forms allied to *Carinella*, is only the anterior portion of the body. It is drawn back again by its retractor. How far backwards the proboscidian sheath reaches in *Carinina* could not be made out, as I only possessed two small anterior fragments, in neither of which the proboscidian sheath terminated. The proboscis itself could be examined with detail in the single specimen which was cut longitudinally. An anterior and a posterior portion of different textures are exceedingly distinct. They are separated from each other by a constriction. In the posterior portion the cells are eminently glandular, high and flask-shaped; in the anterior portion they are less high and apparently less glandular (Pl. III. figs. 1, 2). Great differences in aspect, but not in actual texture, are of course occasioned by the different stages of contraction in which the various parts of the proboscis happen to be.

The mouth, situated ventrally close to the anterior extremity, was very small in both specimens. The cellular coating of the œsophagus is very distinct, and the direct application of the œsophageal epithelium against the muscular tissue most marked (Pl. IV. fig. 3), not even a basement membrane separating the two, whereas a suspension of the intestine by means of the gelatinous tissue is of common occurrence in other forms. The longitudinal sections prove that further back the intestine does not continue as a straight tube as it sometimes does in Palæonemertea, but is constricted (Pl. IV. fig. 2), the constrictions and resulting cæca being, however, much less marked and prominent than in the Schizonemertea and Hoplonemertea.

Right and left of the intestine are situated the two longitudinal blood-spaces, which are direct continuations of the blood-spaces already noticed in the head, and which communicate with these by passages that are encircled, together with the proboscis and its sheath; by the annular nerve ring formed out of the right and left halves of the brain and their superior and inferior commissures.

The arrangement of these spaces has been fully described for *Carinella* by Oudemans,[1] and I may refer to that description, the arrangement being on the whole very much the same. There is no median dorsal blood-vessel in *Carinina*, and there is a very distinct internal epithelium to the longitudinal blood-spaces, two of which are figured on Pl. IV. figs. 2, 5, 6.

Transverse vessels of communication are not present in these two forms. I may perhaps remark that my researches (XIV.) on the development of one of the Schizonemertea have rendered it probable that also in the Palæonemertea we shall have to look upon the blood-spaces in the same light as upon the cavity of the proboscidian sheath, viz., as a direct derivative or continuation of the blastocœle, for which cavities (in the adult state) I have proposed the name of archicœle.

The nephridia are situated partly in the anterior portion of the blood-spaces, another portion traversing the muscular body-wall and leading to the exterior.

In the portion of the paired nephridia exclusive of this excretory duct we may distinguish two distinct parts, one a continuous tube of varying dimensions, formed out of very regularly arranged cells with large nuclei, but not in any way forming a series of perforated cells such as are known in the nephridia of both *Turbellaria* and *Discophora*.

These cells are distinctly ciliated and figured on Pl. IV. figs. 4–6, *Nc*. The structure of the second part of the nephridium is not so easily unravelled, and my preparations of the two specimens do not suffice to reveal all the details. I find it to consist of a cellular mass of spongy appearance protruding along a certain distance into the blood-space, here and there giving evidence of a tubuliform structure, no internal funnels being, however, anywhere recognisable (Pl. IV. figs. 4–6, *N. sp.*).

I must here remark that the researches of Oudemans, who described in detail the arrangement of the nephridia of *Carinella* and *Carinoma*,[2] render it very possible that in

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[1] *Quart. Journ. Micr. Sci.*, Suppl. volume, 1885.

[2] *Loc. cit.*, p. 71, pl. i. figs. 4, 5; pl. iii. figs. 56, 57.

Carinina internal communications between the blood-spaces and the nephridian channels exist, communications by which the cavity of the blood-spaces is thus directly connected with the exterior. As I have, however, remarked, I could not detect the presence of similar communications in my two specimens.

The aspect of the spongy portion of the nephridium and its connection with the canalicular portion, as well as of this with the exterior, is represented in Pl. IV. figs. 1, 2, 4.

As to the generative apparatus of *Carinina*, I can only observe that one of the Challenger specimens is a male, that the fragment contains only two sperm-sacs in its posterior portion, and that these communicate with the exterior, each by a separate pore. Whether in *Carinina* the sperm-sacs are disposed metamerically as in most Nemertea, or irregularly distributed beneath the dorsal integument as in *Carinella*, could not be made out from this specimen.

The general distribution of integumentary and muscular tissue, as well as of the cavities of the intestine (*D*), the proboscidian sheath (*Ps*), and the blood-space (*bl*) in the body of *Carinina* is indicated by the various figures of Pl. II. The proboscis itself is here indicated by *Pr*, the rhynchodæum by *aPr*.

Family EUPOLIIDÆ.

Eupolia, n. gen.

Polia, delle Chiaje.

Integument generally thick in comparison with the body musculature, the two layers of contractile fibres of the integument never coalescing with the outer larger one of longitudinal body muscles as in certain Cerebratuli. Proboscis and proboscidian sheath thin and inconspicuous. Brain-lobes compact, posterior lobe long, wedged in between the superior and inferior ones. Often a commissure of the longitudinal nerve-stems below the anus. No longitudinal cephalic slits but transverse grooves as in many Hoplonemertea.

The necessity for creating a new generic name for the species of Palæonemertea I am now about to discuss is evident from the following considerations. The generic name *Polia*, when it was applied by delle Chiaje to a genus of Nemertea which he introduced into science (*Polia delineata* being the typical species of this genus) had already been preoccupied in Zoology by Ochsenheimer, who in 1826 so designated a genus of Lepidoptera. This reason alone suffices to reject it henceforth from Nemertean nomenclature, and this rejection is also facilitated by the fact that the same generic name has been used by other naturalists, such as Quatrefages (XXVIII.), Schneider (XXXI.), &c., for Nemertea widely different from delle Chiaje's type. It was an error of judgment on my own part, when giving my critical revision of Nemertean genera and species (VII.), to retain the name *Polia* in that list, although I was aware of its inapplicability according to the accepted rules of nomenclature. I retain delle Chiaje's *Polia delineata* as the type species for *Eupolia*.

Eupolia delineata, (delle Chiaje) Hubrecht (Pl. VII. figs. 9, 10).

This species, which is very common in the Mediterranean, more especially at Naples, is represented in the Challenger collection by one fragmentary specimen, captured at St. Vincent, one of the Cape Verde Islands. The fragments showed no head, but the characteristic colouring of the specimen by thin brown stripes on a lighter brown background, was still so distinct in the spirit specimen, that even in the absence of a head, I do not hesitate to identify this form with the above-mentioned species, especially after comparing the sections through the fragments with those through Mediterranean specimens.

In one of the fragments, which is the tail, a terminal commissure between the two nerve-trunks can be demonstrated; by a curious twisting of the fragment the sections seem to prove this commissure to lie above the intestine. Such a commissure is found in other species of Nemertea (*e.g.* *Amphiporus*, *Drepanophorus*), but a close inspection soon reveals that here, and also in other *Eupoliæ*, the posterior commissure is indeed found *below* the posterior portion of the intestine instead of above it.

In M'Intosh's preliminary notes on the Challenger Nemertea, I find a notice made of this specimen to the following effect:—"The specimen is incomplete, neither head nor tail being present. The body is firm and rounded, measuring about 45 mm. in length and about 8 mm. in diameter at the wider part anteriorly The body is closely striated longitudinally, dorsally, and ventrally by alternate white and brownish belts, the pigment constituting the latter being situated on the inner side of the basement layer of the cutis, which forms a simple stratum."

Eupolia giardii, (M'Intosh) Hubrecht (Pl. I. figs. 7–9; Pl. V.; Pl. VI. figs. 4–11; Pl. VII. figs. 4, 5, 8; Pl. X. fig. 6; Pl. XI. fig. 12).

Euborlasia giardii, M'Intosh, *in litt.*

This new species, which shows interesting peculiarities, is represented by one specimen, which was cut up into different portions when I first examined it, so that I can only give a sketch of the head but no figure of the animal *in toto*.

A well-marked peculiarity of this species of *Eupolia* is its shortness, which even surpasses that of *Eupolia curta* from Naples.

The head shows (see Pl. I. figs. 7–9) a faint annular constriction, not continuous in the median ventral line. In this constriction the right and left external openings leading into the posterior brain-lobe are situated. Judging from what we find in other

Eupoliæ, I suppose that this constriction is not so marked in the living animal, but that here, as in the Mediterranean species, two very shallow, strongly ciliated grooves in the integument, curving laterally round both sides of the head, were present, and that, during the process of preservation in spirit, the fold just mentioned made its appearance in the region where normally these transverse grooves are situated.

What immediately distinguishes *Eupolia giardii* from its congeners is the thickness of the circular muscular layer in the œsophageal region.

In M'Intosh's preliminary MS. notes on the Challenger Nemertea, I find the following remarks upon this specimen, which he perfectly recognised as a new species (the specific name *giardii* is taken from M'Intosh's provisional label), without, however, at that time referring it to delle Chiaje's Mediterranean genus.

"A comparatively large form, measuring about 40 mm. in length, with a diameter in its widest part of 6·5 mm. This specimen is colourless, bluntly rounded at each end and somewhat fusiform in outline.

"The anterior end is almost truncate, with a dimple in the middle, caused by the proboscidian aperture, and there are traces of a transverse and a vertical groove, thus forming a cross at the tip of the snout.

"The latter is separated from the body by a well-marked fold which probably indicates a furrow, and which on each side does not quite reach the mouth. The mouth occurs on the ventral surface somewhat behind the foregoing furrow and in the form of a triangular dimple. A small aperture (anus) is situated at the dorsal margin of the blunt posterior end. . . . . The small size of the proboscidian sheath is remarkable. It has an external layer of circular fibres and an inner layer of longitudinal muscular fibres. Both are thin. It is continued to the posterior third. . . . . In the middle and towards the posterior third the body-wall presents a decided change from the foregoing—the alimentary cavity forming a large central space and the solid wall is considerably diminished in proportion."

In studying the sections of this species several additional points of interest came to light. Those concerning the brain-lobes will be discussed in the paragraph treating of the nervous system in general; the general aspect of the brain as it may be gathered from a reconstruction of the sections is figured on Pl. V. The outline of the whole of the lobes and that of the internal fibrous core are here figured side by side in order to show the relations of the parts and the actual position of the ciliated canal that penetrates into a separate part of the brain-lobes more clearly. There is a terminal commissure between the longitudinal nerve-stems below the anus (Pl. VII. fig. 8).

The right and left longitudinal nephridial ducts (Pl. VI. fig. 9, *Nep.*) communicate by deferent ductules (Pl. VII. fig. 5, *Nep.*) with the exterior. Of the latter there are several; in the available transverse series through the head and œsophageal region I count five to the left and seven to the right, some of these (sections 298–325 left and

303–308 right, as well as 448–485 left and 450–485 right) being unmistakably opposite. The duplicity of these deferent ductules, as figured on Pl. VII. fig. 5, is the exception; it was only noticed in this one case, all the other ductules being single.

As to the generative cæca I find in this specimen (which is a male) that they are very full, and that dorsally and ventrally they assume a conspicuously lobed and arborescent appearance.

The integument offers many points of interest which will not be detailed here as they will be more fully described in the paragraph devoted to it.

Eupolia australis, n. sp. (Pl. I. fig. 6; Pl. VII. figs. 1–3, 7).

From M'Intosh's notes on this specimen I copy the following:—

"Another type of a whitish colour, measuring about 19 mm. in length and about 2 mm. in its widest part in front. The body is tapered from the wide anterior region to the fractured posterior end. It is rounded in front, somewhat flattened towards the posterior region. The head having been retracted forms a short blunt cone projecting from the folds of the wider nuchal region. No trace of furrows exists, but the mouth seems to be at the bottom of the transverse dimple at the base ventrally. . . . . The inner longitudinal (muscular) layer is peculiar, for its fibres are somewhat regularly arranged, in long, parallel, and occasionally pennate fasciculi, which in transverse section run inward from the former coat. There is a slight hiatus in the dorsal middle line above the proboscidian sheath. . . . . The proboscidian canal is somewhat thin. . . . . The specimen is a male and the sperm-cells form large masses."

The sections showed that the species was distinct from *Eupolia giardii*, which comes from the same locality, as also from the Japanese *Eupolia nipponensis*, which will be described below. They furnish the following data which it may be of use to recapitulate, in order to facilitate identification of the species when it is again captured in the same waters, and may then be described with its external coloration, of which no indication can here be given.

The primary difference between every section of *Eupolia australis* and all the other species of *Eupolia* here described is found in its integument. That portion of the integument which lies outside of the secondary basement membrane, *B* (Pl. VII. figs. 1–3), is by far the most prominent and the thickest portion, whereas in the other *Eupoliæ* it attains only half or even less of the thickness of the whole integumentary layers that are found outside the primary basement layer, *Bct* (Pl. VII. figs. 5, 9). In correspondence with this the secondary basement membrane is much thinner in these latter species than it is in *Eupolia australis*.

The regular distribution of the blood-spaces round the œsophagus, and just behind it, is such that in addition to the medio-dorsal and the two ventral blood-vessels (*br*) it would appear as if there were two other longitudinal ones, situated right and left of the proboscidian sheath (Pl. VII. fig. 1). This may perhaps also turn out to be a special feature of this species.

Certain other peculiarities observed concerning the intestinal system must for the present be passed over in silence, for want of material to verify them. It may, however, be added that the nervous plexus and the dorso-median nerve are much less conspicuous (though present) in *Eupolia australis* than in *Eupolia nipponensis*, where the plexus is in some places very thick (Pl. VII. fig. 11).

In this respect *Eupolia australis* more resembles *Eupolia giardii*, where the plexus is not so very prominent, although the dorso-median nerve (Pl. VII. fig. 4) is distinct though not massive (*cf.*, Pl. XI. fig. 12).

Eupolia nipponensis, n. sp. (Pl. I. figs. 4, 5, 10; Pl. VII. figs. 6, 11, 12).

By this name I wish henceforth to designate a species of which fragments, partly heads, partly posterior body regions, which obviously belonged to different specimens, were collected by the Challenger in the Japanese waters.

The series of sections reveal enough of common characters to deter one from assigning the fragments to different species.

The species is characterised by certain features already alluded to in the foregoing description of *Eupolia australis*. If it resembles *Eupolia giardii* in the disposition of the different layers of its integument, it differs from this species in the absence of the unusually thick circular muscular layer (Pl. VI. fig. 9) found in the œsophageal region of the latter species. The deeper layers of the integument are most conspicuously developed and vacuolated.

That its nervous plexus is more conspicuous than that of the other *Eupoliæ* was noted before, and I may add that in the available sections a very good horizontal aspect was obtained of the brain-lobes, which showed these to differ in certain minor but still easily verifiable points from those of *Eupolia giardii*. The upper lobe appears to be much more cylindrical; so does the inner fibrous core. There is no superior additional gyrus to the superior brain-lobe with special fibrous core corresponding to what is described and figured for *Eupolia giardii* (Pl. V. figs. 1, 5, 7–9; Pl. VI. fig. 8).

The connection between the posterior brain-lobe carrying the ciliated canal and the rest of the brain is, however, very intimate; they are soldered together along a very extensive surface.

As to the proboscidian sheath, one of the sections clearly demonstrates how exceedingly thin and delicate it is, and how the separation of its cavity from that of the blood lacuna is even difficult to observe.

In this as in other species of *Eupolia* the distinction in the œsophageal epithelium between the layer of ciliated cells immediately surrounding the lumen and the deeper layer of granular gland-cells is very marked.

There is no muscular layer in the œsophagus as in *Eupolia giardii* (Pl. VI. fig. 9) or in *Cerebratulus corrugatus* (Pl. XIII. fig. 6); the thick layer of glandular cells just alluded to may here and there show a longitudinal fibre in addition to the radial ones that serve to suspend it in the circum-œsophageal lacuna; for the greater part these cells project freely into this cavity and are bathed by the fluid it contains.

B. HOPLONEMERTEA.

Amongst the Hoplonemertea collected by the Challenger none are so different from those that are at present known as to necessitate the establishment of a new genus. Still several of them present certain notable points of interest by which our knowledge of this order of worms is extended, and which at the same time offer valuable material for more general speculations.

The three genera *Drepanophorus*, *Amphiporus* and *Tetrastemma*, to which all the Challenger Hoplonemertea belong (when we except *Pelagonemertes*) appear to be very cosmopolitan; the same remark, however, applying to the Schizonemertean *Cerebratulus*, as will be shown in the sequel.

Family Amphiporidæ.

Drepanophorus, Hubrecht.

The mouth and the aperture of the proboscis are separate openings. The exceedingly muscular proboscidian sheath communicates with lateral spaces that are metamerically placed, and have thin cellular or membranous walls. The armature of the proboscis often conforms to an aberrant type.

Drepanophorus rubrostriatus, Hubrecht.

This species, although not represented by complete specimens, was dredged by the Challenger off St. Vincent, Cape Verde Islands, in July 1873. M'Intosh identified the fragments before they came into my hands, and remarks upon them in his preliminary notes as follows:—

"Two fragments of a form apparently closely related to *Drepanophorus rubrostriatus*, the two measuring about 14 mm. by about 3 mm. in breadth. The colour of the animal is reddish-brown on the dorsum, with longitudinal pale stripes. . . . .

"The ganglia and cephalic sacs are remarkably distinct and the nerve-cords have a cellular investment. A very remarkable feature is the presence of large granular tubes which communicate with the cavity of the proboscis. . . . .

"The structure of the proboscidian sheath is peculiar, since the longitudinal fibres are clasped in spaces made of the circular coat and in transverse section the lining is papillose."

Not only the remains of the external coloration but also the internal anatomy convinced me of the identity of this fragmentary specimen with the Mediterranean species, which has, moreover, already been found by Langerhans at Madeira. Although

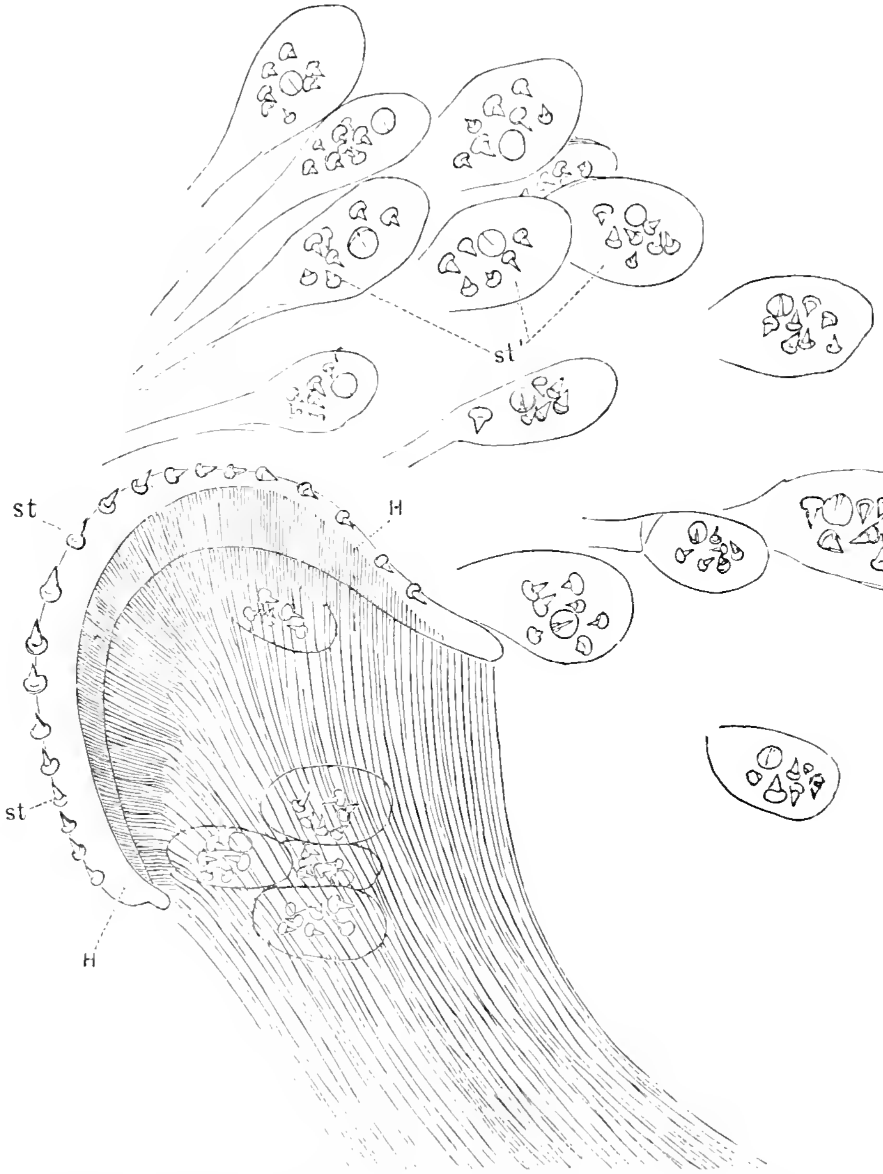

Fig. 1.—Armature of the proboscis of an adult *Drepanophorus serraticollis.* H, curved handle of stylets with muscle-fibres attached to it; *st,* nail-shaped stylets in action; *st',* nail-shaped stylets in accessory reservoirs, the number of these reservoirs more or less corresponding to that of the active stylets, and also increasing with age.

the Challenger specimen contained no proboscis (which had apparently been expelled), I cannot refrain from giving a woodcut of the curious and divergent armature of the proboscis as it was observed by me both in young and in older specimens of *Drepanophorus* from the Mediterranean. In young specimens the number of pointed stylets and of reserve sacs is less considerable. This proboscidian armature is certainly one of the most marked and distinctive features of the genus, although, as we shall presently see, I feel justified in assigning other species to it even when the presence of a similar armature has not been definitely demonstrated.

The specimen was a female; the generative products are, however, yet very far from ripe.

Drepanophorus serraticollis, Hubrecht (Pl. IX. figs. 5, 6; Pl. X. fig. 5; Pl. XI. fig. 8; Pl. XII. fig. 6; Pl. XV. fig. 17).

Drepanophorus serraticollis, Hubrecht, Aanteekeningen over Anat. van eenige Nemertinen, Utrecht, 1874.

Concerning the specimens here referred to this species, I find the following notice in M'Intosh's preliminary MS.:—

"Two specimens were dredged at Station 162 (off East Moncœur Island, Bass Strait), 38–40 fathoms, sand, length about 30 mm., with a diameter of about 7 mm., but both are broken.

"The ventral surface is marked by a median and two lateral longitudinal grooves.

"Externally the dorsum is tinted of a pale madder-brown without stripes. A darker patch runs in the centre of the head in front of the cephalic furrows. The under surface is pale.

"The head is wider than the neck and seems to have been somewhat bluntly conical. The aperture for the proboscis is slightly inferior. It is marked by a prominent ridge indicating the cephalic furrows, which slope slightly forward on each side to the middle line, where they are separated by a short interval. Inferiorly they slope more distinctly forwards and inwards, and are separated by a wide interval, from which a median ridge goes forward to the proboscidian aperture. In front of this furrow, both dorsally and ventrally, there are a series of secondary furrows about thirteen or fourteen in number, running forward from the main groove. . . . .

"In regard to the structure of the proboscis it agrees with the others of the genus, presenting no stylets.

"The proboscidian sheath presents a regularly interwoven or basket-like pattern of circular and longitudinal fibres, and the inner surface is papillose in transverse section. No diverticula seem to be present. . . . . Many ova are found partially projecting through apertures a little external to the nerve-cord and corresponding to the very evident raised line on the ventral surface."

It needs no comment that it is at the least rather hazardous to identify with the Mediterranean species (which seems also to have been examined and figured by Quatrefages when he gave the description of his *Cerebratulus crassus*), a specimen in which the proboscis, as well as its armature, is absent. Still the transverse sections offer such a very close resemblance to those of actual specimens of *Drepanophorus serraticollis*, that it would be again hazardous to establish a new species for the fragments, of which the coloration affords a less decisive clue than in the case of the foregoing *Drepanophorus rubrostriatus*—the madder-brown hue referred to by M'Intosh being all that is preserved of the uniform though bright coloration which the specimen must have had when alive, if it agreed in this respect with the Mediterranean *Drepanophorus serraticollis.*

I have, moreover, hazarded the identification with the foregoing specimens of a third fragment collected in the Kerguelen waters, of which not only the proboscis but also the head was absent. Here, too, the internal characters enabled me to refer the specimen to the genus *Drepanophorus* (the transverse cæca of the proboscidian sheath being in this case the guiding feature).

The systematic position of this specimen thus only rests upon the similarity of the transverse sections and on the general yellow hue of the fragment, darker on the dorsal than on the ventral surface.

The very thick-walled proboscidian sheath with its delicate lateral sacs, different in certain respects from that of a new species of *Drepanophorus* hereafter to be described, is figured on Pl. X. fig. 5.

Drepanophorus lankesteri, n. sp. (Pl. I. fig. 22; Pl. IX. figs. 1, 2, 10; Pl. X. figs. 2, 4; Pl. XII. figs. 5; Pl. XIV. figs. 9, 10; Pl. XV. fig. 13).

Of the three species of *Drepanophorus* contained in the Challenger collection, this is without doubt in several respects the most remarkable. One specimen measuring 30 mm. in length and 3½ mm. in breadth was obtained; it was dredged at Station 49, in the waters of Nova Scotia. As to its colour when alive, the spirit specimen allows of no other certain conclusion than that the dorsal surface is darker than the ventral, which may have been whitish. No special markings are now traceable on the dorsal integument, and we may thus surmise that its natural colour, which has been only partly preserved in spirit, was in life brown or red.

If I nevertheless feel justified in creating it a new species, it is because certain internal characters are so well marked as to allow of no confusion with the species of *Drepanophorus* hitherto known.

The two characteristic features which immediately attract attention in studying a series of sections through this species are, first, the presence of a series of transverse commissures (Pl. IX. fig. 10) metamerically placed at intervals of about 0·2 to 0·15 mm., and connecting the two longitudinal nerve-stems all along their course below the intestinal cæca. Close to the posterior end of the body I cannot vouch for their presence; their extreme tenuity, and a folding of the sections, preventing the transverse commissures, if present, from being seen. Nor could I make out with certainty in the one specimen available, whether the longitudinal stems themselves coalesce *above* the anus as they do in the other Hoplonemertea, but on *a priori* grounds, I can hardly doubt their doing so.

Anteriorly, the transverse commissures were present even in the immediate neighbourhood of the brain, up to the point where the so-called vagus nerve branches off and stretches forwards towards the œsophagus.

Although, on the whole, they have a very regular course, and are situated at equal intervals, still a few irregularities in these commissures must be noticed; some of them branching into two, others being connected with the preceding or the succeeding commissure by a small bundle of nerve-fibres.

The significance of this nervous arrangement will be discussed further on.

The second characteristic to which I wish to draw attention is the presence of transverse cæca belonging to the proboscidian sheath. Although they are present in other species of *Drepanophorus*, so that we are justified in looking upon their presence as one of the typical generic characters, still I never found their walls so markedly developed as in *Drepanophorus lankesteri*. Generally the walls are exceedingly thin and membranaceous (*e.g.*, *Drepanophorus rubrostriatus*); here, however, they attract attention by the thick cellular coating which immediately reveals its presence both in longitudinal and in transverse sections. On Pl. X. fig. 4, the nature of this arrangement is clearly shown. Another peculiar feature of these cæca of the proboscidian sheath is that I have found a few of them coalescing peripherally with the one preceding or following them by means of a short longitudinal extension, which allows these few successive cæca to intercommunicate not only by means of the proboscidian cavity, but also by means of this distal connection.

The muscular body-wall of this, as of most other Hoplonemertea, may be shown to contain, in addition to the two layers α and β (*cf.* Pl. XI. fig. 8), certain cross fibres not forming a definite layer, but arranged at angles of 45°, and visible in sections parallel to the surface.

The openings of the longitudinal canals of the nephridia to the exterior are situated ventrally, posteriorly, and at the same time terminally; this constitutes another difference as compared with *Drepanophorus rubrostriatus* which has been already described and figured by Oudemans.[1] On one side of the specimen investigated two openings of the nephridial duct piercing the integument are at all events observable, although somewhat more internally, before these deferent ducts have pierced the muscular body-wall, they coalesce. There is a very close proximity between the anterior nephridial ramifications and the lateral longitudinal blood-vessels. They do not, however, intercommunicate, nor do, as was supposed by M'Intosh, the proboscidian sheath-cæca and the blood vascular system.

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[1] *Loc. cit.*, pl. i. fig. 7.

Eyes are present in *Drepanophorus lankesteri*. In the (detached) posterior lobes of the brain there is a double canal as in most other Hoplonemertea, the one branch taking its course along the glandular cells, the other in the ganglionic part of this brain-lobe.

As to the sexual elements, they are in this species enclosed in sacs that are ventrally situated, and although I have only one specimen at my disposal, which is just beginning to ripen, I still believe I may lay it down as a rule for the species that the genital cæca are arranged in pairs in the vicinity of each nerve-stem, so that four are very often simultaneously met with in one section. This is, as we will presently see, a more complicated arrangement than that which obtains in the other species of *Drepanophorus*, but it is a simplification of the more profuse and less regular distribution of the genital sacs, as it occurs in *Amphiporus moseleyi*.

Amphiporus, Ehrenberg.

Stylet in the proboscis of the normal shape. Oral and proboscidian aperture confluent. No lateral cæca to the proboscidian sheath. Numerous longitudinal nerves in the proboscis as in Drepanophorus.

Amphiporus moseleyi, n. sp. (Pl. I. figs. 20, 21; Pl. IX. figs. 4, 7–9, 11; Pl. X. fig. 3; Pl. XV. figs. 11, 12, 20).

Professor M'Intosh has drafted the following notes on a provisional examination of the specimens before they were handed over to me, which I may here be allowed to insert:—

"A large flattened species, the largest specimens about 68 mm. in length, and about 12 mm. at the broadest part. The body in those best preserved is somewhat flattened and with an acute edge along both sides of the tip of the tail. Anteriorly the body is thick and rounded both dorsally and ventrally, but posteriorly it is much flattened. In the preparation the anterior end is more pointed than the posterior. The ventral surface throughout is flatter than the dorsal.

"The larger specimens are deprived of much of their cutaneous tissue so that they are comparatively pallid; in one (the smaller) the dorsum is of a dull blackish-grey; while the ventral surface is either whitish or pale greyish. The lip of the snout is pale, and from this a pale line runs backwards to the tail on each side. This is not altogether due to pigment, for in those devoid of cutis a very evident whitish band is found along the anterior third, but it becomes indistinct posteriorly.

"The head is somewhat truncated anteriorly and marked by a series of eyes which are rather deeply seated. In the large specimens these form a marginal band on each side along the antero-lateral margin of the snout. In the smaller a series begins on each side of the median line of the snout and runs in a tolerably straight line backwards to the slight narrowing of the furrow, while a somewhat triangular area superiorly is covered with similar eyes. The posterior boundary especially being so distinct as almost to make a special row.

"Behind these a band of similar eyes runs upwards and slightly forwards, a considerable interval on the summit of the dorsum separating those of each side.

"The cephalic furrows slope outwards and backwards on each side to the margins dorsally, and from the latter point are continued ventrally outwards and forwards.

"So far as can be observed in this form only a single aperture exists for the proboscis and mouth. This forms a well-marked slit in the ventral surface, a little behind the tip of the snout. . . . .

"In minute structure the proboscis corresponds to that of the typical form . . . . the stylet is simple and normal."

To this description of the external characters I have nothing to add, but may proceed to remark that the examination of the internal structure by means of sections has revealed the significance of the white lateral stripe, noticed by Professor M'Intosh as not being due to pigment. It is, indeed, a peculiar feature by which this species is characterised, and which I have hitherto *not* observed in other Nemertea. All along the extent of this lateral and longitudinal whitish line (Pl. IX. fig. 8) the sections show the presence of numerous glandular (or sensory ?) cavities, opening to the exterior by very numerous pores piercing the integument, and both accumulated at, and limited to, the region where the dorsal musculature merges into the ventral (Pl. XV. fig. 11), and where, as in so many Hoplonemertea, the muscularity of the body-wall is reduced to a minimum, *i.e.*, in the right and left lateral line. In the posterior portion of the body these organs were no longer present; anteriorly, however, they could be traced even in the head (Pl. X. fig. 3, *gls.*). Further details about their structure will be given in the anatomical part of this Report.

The other chief peculiarities of the species which are revealed by a study of the sections, and which must be briefly enumerated in this summarising description, are:—the situation of the longitudinal nerve-stems, in the portion of the body where the intestinal cæca are clearly developed, *above* these cæca about one-third or halfway between the lateral margin and the proboscidian sheath. It should be remarked that this arrangement is the opposite of what is observed in *Drepanophorus*, where the longitudinal nerve-stems, as elsewhere described, have their course *below* the intestine, or below the lateral cæca. The significance of this different arrangement will be elsewhere discussed; in itself it is a feature very much facilitating the discrimination of *Amphiporus moseleyi* from other *Amphipori*, where the nerve-stems are found much more strictly laterally, at least in those hitherto known. There is a very distinct commissure between the longitudinal stems *above* the anus.

Another most characteristic feature which may generally be distinguished in every transverse section of the animal, especially when it is ripe for reproduction, is the situation of the numerous reproductive receptacles. These are not situated alternately between each pair of intestinal cæca right and left, as we find in the majority both of Hoplonemertea and Schizonemertea. In *Amphiporus moseleyi*, the distribution of the genital receptacles appears to follow a more primitive arrangement, and offers many points of similarity with what obtains in the Palæonemertean *Carinella*, where there is not yet a regular metamerical arrangement of the genital sacs, but where there are short independent cavities, irregularly distributed under the dorsal body-wall, which they pierce by means of short ducts. The outer openings of these ducts are seen on the dark dorsal surface of the animal as so many fine white dots irregularly spread between the transverse and longitudinal white lines that form such well-defined external markings in the species in question.

Amphiporus moseleyi, as will be seen on comparison of figs. 4 and 7 of Pl. IX., has its generative sacs distributed very much in the same way, with this difference, however, that generative pores are situated not only on the dorsal but also on the ventral surface of the animal. When the animal is very ripe and the generative sacs are overfilled, it is manifest that this specific character may be more easily detected in every transverse section than in young or unripe specimens. As many as seven separate sacs in one section were noticed. Both the male and female sex were found to agree in this respect.

Another character peculiar to nearly all *Amphipori*—the coalescence of the oral and the proboscidian aperture into a common wider opening, situated just below the tip of the snout—is also met with in *Amphiporus moseleyi*.

Amphiporus marioni, n. sp. (Pl. IX. fig. 3; Pl. X. fig. 1; Pl. XV. figs. 14, 15).

A second species of *Amphiporus* is represented in the Challenger collections by two specimens, the larger coming from Marion Island, and having been collected on December 26, 1873; the other from Christmas Harbour, Kerguelen, at a depth of 120 fathoms.

The place at which the first specimen was obtained was an inducement to dedicate this species, in preference to any other of the novelties of the Challenger, to the indefatigable naturalist of Marseilles, so well known by his numerous researches in the field of invertebrate morphology.

Amphiporus marioni, was one of the larger sized specimens, measuring $5\frac{1}{2}$ mm. in diameter anteriorly in its widest region. The body musculature may be said to be stronger than in most of the other Hoplonemertea (*cf.* Pl. IX. figs. 1–6); the longitudinal muscular layer shows a very marked pennate arrangement of the bundles (Pl. X. fig. 1) between which the gelatinous tissue penetrates, carrying with it massive nerve-stems which assume a more or less flattened, plexus-like arrangement, just between this longitudinal layer α and the circular layer β (Pl. X. fig. 1, *ne*). The proboscidian sheath is also very muscular; the proboscis has the stylet of the normal Ampiporean shape.

The nephridial system is comparatively short and has one pair of deferent ducts situated at the posterior extremity; the longitudinal canal is anteriorly very copiously branched (Pl. X. fig. 1, *Nep*).

There is a very thick basement membrane (*B*) to the integument, and very strongly developed gelatinous tissue (*Gt*) inside the muscular body-wall. Curious granular enclosures (*inc*) occurring in this tissue, both in the head and in the body, will be elsewhere described.

The longitudinal nerve-trunks are not wholly lateral but nearly so; there are no ventral commissures between them.

The generative cæca assume the ordinary character of paired dorsal receptacles metamerically distributed between the intestinal cæca. The generative pores are dorsal and situated above the nerve-trunks.

The ova, present in both specimens, are in both of them characterised by a curious refractive body constantly present in addition to the nucleus, and staining deeply with picrocarmine. This "paranucleus" can be seen to be present at the very earliest stages of the development of the eggs which came under observation; stages at which the eggs could still hardly be distinguished from the surrounding cellular elements in the wall of the generative cæca (Pl. XV. figs. 14, 15).

Family TETRASTEMMIDÆ.

Tetrastemma, Ehrenberg.

Eyes four; arranged so as to indicate a square or oblong. Specimens generally small.

Tetrastemma agricola, Willemoes Suhm.

Of this species, collected by Suhm in Bermuda (Mangrove swamps, Hungry Bay) and which is the only Land Nemertean procured during the voyage, no specimens have been preserved, although Suhm tells us that he collected a good many of them. So I must content myself with reproducing the chief points of its anatomy as they were made out by him in the Ann. and Mag. Nat. Hist. for June 1874. At the same time I have reproduced one of his figures in woodcut. Suhm writes (*loc. cit.*, p. 409):—

"The largest of these worms have a length of 35 mm. by 2 mm. in width. They are of a milky-white colour. Their movements are slow and sometimes catterpillar-like; they shoot out their long proboscis, fix it at some distant point to which it adheres by means of its papillæ, and draw their body after them. Their skin is filled with rod-like bodies as described by Max Schultze and others, and is covered on the outside all over with cilia. In the front we find two pairs of eyes, one of them near the entrance of the proboscis, the other smaller one further out; they consist of a fine granulated pigment, imbedded in a colourless substance, which holds these granules together, in which, however, a regular lens could not be observed; underneath these eyes is seen the prominent centre of the nervous system (fig. 1, *g*); it consists of two lobes and a ring which connects them and encircles the proboscis. From the lobes depart the two lateral nerves (*n*) and some other cephalic nerves, which were not quite clearly visible. . . . . The cephalic fissures or ciliated sacs . . . . are either very small or wanting entirely. Sometimes a folding of the skin seemed to indicate their presence; but in the contractile bodies of these worms it is very difficult to say whether you have a small cephalic fissure or a folding of the skin before you.

"Underneath the ganglion, on the under surface, is the semicircular opening of the mouth (*o*) leading into an intestinal tube (*i*), which runs through the whole length of the animal, without showing anything particular, and is terminated by an anus (*a*). . . . . The proboscis is divided into two portions—the papilligerous part and the glandular part. At the bottom of the former we find a peculiar spine . . . . this spine is remarkable because it differs in form according to the sex of its owner. In the male it has a rounded base and is pear-shaped (fig. 2, pr^3),[1] while in the female the base has sharpened angles (fig. 3, pr^3).[1] I do not think that such sexual differences have hitherto been observed in Nemerteans.

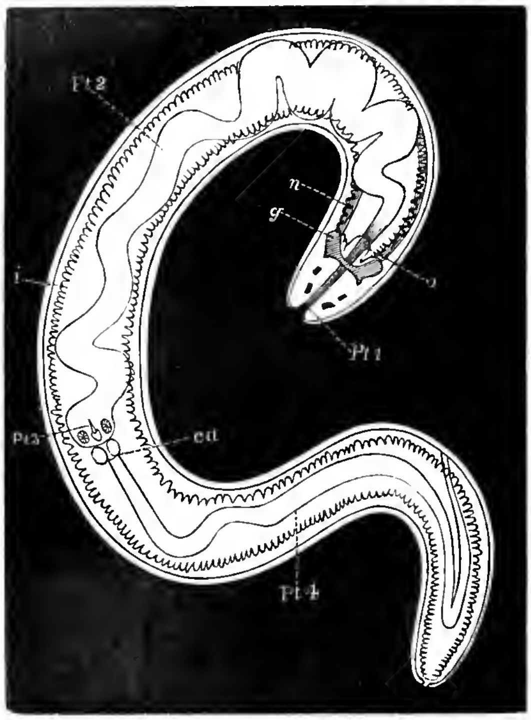

FIG. 2.—*Tetrastemma agricola*, Willemoes Suhm. *o*, mouth; *g*, brain; *n*, lateral nerve; *i*, intestine; *Pt* 1, rhynchodæum; *Pt* 2, papilliferous; *Pt* 4, glandular part of the proboscis; *Pt* 3 and *ca*, region of the stylet and reservoir.

"The ovaries and testes are, as usual, situated between the intestine and the walls of the body. . . . . I . . . . establish for it the specific name of *agricola*, as there is probably no described marine species of *Tetrastemma* with which it could be identified.

"I, however, do not attach much importance to this point, as the object of these lines is only to show that in America also land Nemerteans exist. Hitherto they were only known from the Pelew Islands, where Semper has found another, to which he has given the name of *Geonemertes palæensis*. I think it is highly probable that land Nemerteans exist to a greater extent in tropical countries than has hitherto been supposed, and that from their hidden life, and the impossibility of preserving them, they have hitherto escaped the attention of travelling naturalists. Especially in such islands as the Bermudas, where the earth of the lower grounds contains a great deal of salt, it may easily be imagined how marine animals have taken to terrestrial habits; and it was interesting for me to see that one *Tetrastemma*

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[1] These figures referred to by Suhm have not been here reproduced.

when put into salt water would live there for twenty-four hours, but when put into fresh water died after a few hours time. Fresh water, however, poured over the earth which contained them, did not damage them in the least."

Tetrastemma fuscum, Willemoes Suhm (*nec* Œrsted).

A second species of *Tetrastemma* was noticed by Suhm during the first year of the Challenger cruise. In the paper just referred to, in which he describes *Tetrastemma agricola*, it is noticed in the following words:—

"I may here also add that on our cruise from the Bermudas to the Azores I found parasitical Nemerteans on *Nautilograpsus minutus*, one of the gulf-weed crabs. They were small brownish animals, and occupied especially the underside of the crab, under the abdomen of which I found most of them. They did not exceed the length of 2 mm. and in none of them could I see genital organs. In fig. 4 I have figured one of these small parasites, which probably also belong to the genus *Tetrastemma*, though the second pair of eyes is only punctiform, situated on both sides of the proboscis. Nervous system and digestive apparatus do not present anything particular, and the proboscis (fig. 4, pr^1, pr^3), is remarkable for its shortness.

"I do not think that these worms attain their full size on the crab, but believe them to be young parasitical stages of some Nemertean which possibly lives on the gulf-weed."

In his journal, of which an abstract is given in the Narrative of the Cruise, vol. i. p. 169, Suhm further remarks about this species:—

"The worm presents no modification induced by parasitism; it appears to be a new species, and from its colour may be called *Tetrastemma fuscum*. . . . The ganglia are especially large and conspicuous. . . . The proboscis is very short, and distinguished from all other species I know of by having the stylet-sac placed close behind the ganglion and just above the mouth. . . . Length 0·75 mm., breadth 0·25 mm."

Suhm was apparently not aware that the specific name which he gives to his specimen was preoccupied for another *Tetrastemma*, as early as 1844, by Œrsted for the species that is now known as *Tetrastemma dorsalis*.

No specimen being preserved, the special features enumerated by Suhm do not justify me in proposing a new specific name. For completeness' sake it was, however, necessary to mention his observations.

Family PELAGONEMERTIDÆ.

Pelagonemertes, Moseley.

Pelagonemertes rollestoni, Moseley.

It was indeed a novel and startling fact when detailed news[1] appeared regarding the capture by the Challenger naturalists of a pelagic Nemertean, which, in addition to other

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[1] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xv. p. 165, 1875; vol. xvi. p. 377.

characteristic differences, was recognisable by a change in the constitution of its tissues, similar to that which is noticed in pelagic animals belonging to other groups, when compared with their non-pelagic allies, viz., the hyaline transparency of the body, with undiminished, or even with rather increased bulk. The first specimen captured was a ripe female, the second a very young female. No further specimens were met with. The first specimen, though somewhat lacerated, was preserved; the second was observed alive and figured, but was destroyed. Before mentioning the results which have been obtained by a careful microtomy of the available specimen, I will here insert in full the interesting descriptions with which Professor Moseley furnished us as early as 1875,[1] soon after the specimens were captured, and when he had been able to observe them in the fresh state. His first article[2] On *Pelagonemertes rollestoni* runs as follows:—

"This remarkable form was found in the trawl, together with a number of deep-sea animals, from 1800 fathoms, near the southern verge of the South Australian current, lat. 50° 1′ S., long. 123° 4′ E., March 7, 1874. Its appearance at once pronounced it a pelagic animal, the body being gelatinous and transparent as in *Salpa*, with the exception of the alimentary canal, which stood out in relief, being of a deep burnt-sienna colour (as is the nucleus in many *Salpæ*), and the region of the sheath of the proboscis, which was less transparent than the remainder of the body. The animal was living when obtained, and when placed in fresh sea-water gave evidence of life by a feeble, irregular, peristaltic contraction of the external muscular tunic, which increased on irritation; the proboscis was also protruded and retracted several times.

"The animal was about 4 cm. long and 2 broad, and 5 mm. in thickness. Hence its dimensions, and especially its thickness, render it unfavourable for a perfect examination of its structure under the microscope whilst in the entire condition. As only one specimen was procured, and as this was believed to be unique, no dissection was resorted to, excepting the removal of a small portion of the epidermis and external muscular tunic for microscopic examination. Hence the investigation of the structure of this Nemertine necessarily remained an imperfect one, and the affinities of the animal amongst other Nemertines could not be determined.

"The animal is leaf-like in shape, narrowing to a blunt point at the posterior extremity, and commencing abruptly at the anterior. The proboscis is protruded from the summit of a protuberance occupying the middle region of the anterior extremity. The mouth is situate on the ventral surface of the body, just posterior to the aperture for the proboscis. It is a simple aperture with a plaited margin composed of five or six folds. It is the commencement of a short muscular tube, the œsophagus, which was seen to pass behind the most anterior prolongation of the main mesial digestive canal, but the communication of which with the latter was not traced. The digestive system stands

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[1] *Ann. and Mag. Nat. Hist.*, 1875, No. 87 and No. 96.

[2] The figures which accompanied the article have all been reproduced on Pl. I. figs. 24–27.

out very conspicuously in the fresh condition of the animal, from being of the deep burnt-sienna colour already mentioned. It consists of a broad, flattened mesial canal, somewhat broadest in the middle region of the body, anteriorly ending in a bluntly terminated cæcal prolongation, and posteriorly narrowing gradually. As the posterior part of the animal was somewhat injured it could not be determined whether the canal terminates in an anus or not.

"The mesial canal receives on either side lateral tributaries in pairs, which tributaries remain simple for some distance of their horizontal course, and then break up into ramifications. The most anterior pair of lateral canals is split up into by far the most ramifications. The ramifications become less and less in each pair towards the posterior extremity of the body, some of the most posterior lateral canals being simply bifurcate, and one merely enlarged at the extremity. There are thirteen pairs of lateral canals in all.

"The nervous system was plainly seen in part. A pair of rounded ganglia lie on the ventral and lateral surface of the sheath of the proboscis, being a little posterior in position to the mouth. A commissure passes above the œsophagus and between it and the proboscis-sheath. From the ganglia a pair of fine simple nerve-cords pass in a curved course down to the posterior extremity, where their termination could not be ascertained.

"The cords cross ventrally the lateral digestive canals about the point where ramification commences. Further connections of the ganglia could not be ascertained.

"The specimen obtained was a female. A series of ovaries, consisting of pear-shaped masses of minute ova, were present, situate between each of the pairs of lateral digestive tubes immediately external to the nerve-cord on each side. The masses of ova are contained in small cavities in the gelatinous internal body-tissue. When pressure was exerted the ova issued from small corresponding apertures on the ventral surface, and the small empty cavities remained. The ova were spherical, about ·28 mm. in diameter, and appeared composed of fat-globules and granular matter.

"The proboscis-sheath, which is wide and capacious, is very plainly seen on the dorsal aspect of the body, and dimly through the thickness of the body from the ventral aspect. It has a firm muscular attachment at its orifice, and bundles of muscular fibres (apparently retractor) are attached to it here on either side (pl. xv. fig. B, 1 = Pl. I. fig. 24). The proboscis itself is, when retracted, coiled up in the usual manner within its sheath, as seen in fig. D (= Pl. I. fig. 25). It could, unfortunately, not be ascertained whether the proboscis is armed or not. It was never entirely retracted, but a small portion of it always remained exserted.

"The outer surface of the body of the Nemertine is covered with a hyaline, very thin integument, which is thrown into numerous folds and wrinkles, which are so arranged along certain lines around small spaces nearly free from them as to produce on the surface of the body an appearance of a series of small polygonal areas, separated by fine reticular network (fig. D = fig. 27). This condition of the surface was most conspicuous about the anterior part of the body, but the body was much lacerated by the meshes of the trawl, and, therefore, I cannot say whether the whole integument is in this condition in the fresh state or not. The folds and plaits in the integument are so sharp that they give the appearance under the microscope of somewhat spindle-shaped bodies with sharply pointed extremities (fig. C, 1, 2, 3 = fig. 26). At first I supposed that these bodies were urticating organs, resembling those of *Bipalium*, but on carefully teasing up a portion of the integument with fine needles, and being unable to isolate a single one, I concluded that they were mere folds. They are, however, of remarkable appearance, from their extreme abundance and the manner in which they cross each other at all angles. They are well preserved in glycerine preparations of the skin hardened in picric acid.

"Beneath the integument is some granular glandular matter. Immediately beneath the integument, and in close adherence to it, is the muscular tunic, evidently the homologue of the cutaneous muscular system of *Bipalium* and other Planarians. As in these, the outermost fibres are circular in direction, the inner longitudinal.

"The muscular tunic encloses the entire body. It is thin, and in the fresh condition of the animal transparent and inconspicuous, but becomes opaque when the animal is hardened in picric acid. The inner longitudinal layer consists of stout bands of fibres running parallel to one another. The outer circular fibres are far less developed, and are not gathered into bundles, but cross one another slightly obliquely in their transverse course, forming a slight meshwork over the longitudinal fibres.

"Beneath the muscular tunic and between its meshes the body mass is filled up with a gelatinous, hyaline, structureless matter, imbedded in which lie the viscera and the muscles attached about the orifice of the sheath of the proboscis. Internal muscles, except those referred to, were not observed.

"No eyes or other sense-organs were found, and ciliated sacs were not seen.

"From the circumstance of the only specimen of *Pelagonemertes* having been much lacerated, and from the animal not having been dissected, it will of course require further examination. In the specimen as procured there was a deep constriction of the body at about the junction of the first with the second fourth of its length. This, it appeared pretty evident, had been caused by the meshes of the net. The posterior extremity was somewhat injured, and its form may not be quite correctly given. Ciliated sacs may be present, and the structure of the proboscis might throw light on the affinities of the animal.

"The form of the digestive system is the most remarkable feature about *Pelagonemertes* in its close resemblance to that of *Dendrocœla*. In other respects *Pelagonemertes* is thoroughly Nemertine in structure, being merely modified for pelagic existence. It is remarkable that the gelatinous hyaline mass of the body is not tegumental in character, but apparently homogeneous with internal structures.

"The occurrence of a peculiar burnt-sienna colour in many very different pelagic animals is remarkable. With many the colouring may be explained as protective resemblance to the oceanic seaweeds. For its occurrence in others, such as *Salpa* and *Pelagonemertes*, in an otherwise hyaline body, there may be some common cause, possibly also protective.

"Diagnosis of the genus *Pelagonemertes*, H. N. M. :—*Body leaf-shaped, gelatinous, hyaline. The anterior extremity of the body broad and abrupt, the posterior narrowed to a point. The digestive canal with thirteen pairs of lateral ramifications, as in Dendrocœla. Integument thin and hyaline, with a thin muscular tunic immediately beneath it, consisting of external circular and internal longitudinal fibres. The animal free-swimming, oceanic.*"

Moseley's second article, which appeared nine months later, was again accompanied by figures, which will be found reproduced on Pl. I. figs. 23, 28–31. The contents were as follows :—

"On June 5, 1875, in lat. 34° 58′ N., long. 139° 30′ E., about halfway between Vries Island, Oosima, and Cape Sagami, the trawl was used by H.M.S. 'Challenger' in from 755 to 420 fathoms. A young specimen of a peculiar pelagic Nemertean, which has been described by me (Ann. and Mag. Nat. Hist., ser. 4, vol. xv. p. 165, March 1875) under the name of *Pelagonemertes Rollestoni*, in honour of my friend and instructor Professor Rolleston, was found by Dr. von Willemoes Suhm adhering to the net, and by him handed over to me for examination. The adult specimen before procured and described was in a similar manner found adhering to the trawl-net after a deep-sea dredging by Dr. von Willemoes Suhm.

"The animal was very much smaller than the one obtained before, measuring only 13 mm. in extreme length, and 11 mm. in extreme breadth, and about 1 mm. in extreme thickness. It was in good preservation when found, and living, and, being extremely transparent, much more of its structure could be observed than in the case of the more full-grown specimen. Unfortunately, an attempt to preserve the specimen by treatment with perosmic acid and subsequent action of glycerine failed, and the specimen perished. The trawl came up late in the evening, when only an hour of daylight remained; the examination made was thus a hasty one.

"The animal showed the same feeble pulsating movements which had been shown by the adult.

"The external gelatinous investment of the body was perfectly transparent, and none of the peculiar corrugations of a thin superficial epidermic layer were visible as in the adult specimen. The contours of the body were well preserved, including those of the hinder portion, which was broken in the specimen before obtained.

"The forepart of the body is wide, with rounded margins; the posterior narrowed, with a series of indentations on its margin corresponding to the successive pairs of diverticula of the digestive tract. At the extreme hinder termination of the body is a shallow notch, at the bottom of which is the anus.

"The mouth, which is a simple opening at the apex of a small, short, conical protuberance, was situate just in front of the nerve-ganglia on the ventral surface of the body (it is not shown in the figure, which represents the animal from the dorsal aspect).

"The central canal of the digestive tract terminated in front in a wide, rounded, blind end, and tapered gradually to the anus at the posterior end of the body.

"The lateral diverticula in this young specimen were evidently in an immature condition, and the successive pairs showed successive stages of development, the most anterior being the most fully formed. This most anterior pair is the only one which shows a commencement of ramification at the peripheral extremities. The ramifications, so ample and well marked in the adult worm, are seen here to be developed as cæcal buds from the outer ends of the long diverticula. The diverticula themselves, of which five pairs were present in the young specimen here figured, arise, as can be seen from the figure (pl. xi. fig. 1 = Pl. I. fig. 23), as simple lateral buds from the central digestive tube. These buds gradually increase in length, their peripheral cæcal ends being always larger than the tubes connecting these with the central digestive tract, and eventually these cæcal ends give off buds and form ramifications. A slight enlargement in the rectum, situate just anteriorly to the anus, and shown in the figure, probably represents the spot where a sixth pair of diverticula were about to bud off from the digestive tube. The diverticula, with the exception of the first pair, were not placed exactly opposite one another, the right diverticulum in each pair being situate anteriorly to the corresponding left one.

"The digestive tract was filled with a dark reddish-brown matter, consisting of large granules and oil-globules. The contents of the diverticula were darker and more opaque, and contained numerous clear oily globules of a bright yellow and bright red colour, mingled with similar opaque globules (fig. 4, *a* = fig. 28). The brightly coloured globules exactly resembled those of the main tract. Similar coloured globules occur in larval Nemertines, and I have observed them also in a marine Planarian larva, possibly that of a *Thysanozoon*, or the Planarian larva described by Johannes Müller from the Mediterranean, supposed to be that of *Eurylepta* (Claus, 'Grundzüge der Zoologie,' p. 286).

"The sac of the proboscis corresponded exactly with that described in the adult. It was here found to terminate posteriorly in a blunt point at a short distance from the hinder end of the body. The fluid contained in it appeared transparent and without corpuscles. The proboscis itself could be carefully examined in the present transparent specimen. It was without stylets and quite simple, invaginated in the usual manner; it was not seen fully protruded, but when so protruded must be slightly longer than the animal's body; it has an outer pellucid gelatinous investment, and an inner muscular layer (fig. 5 = fig. 29). No retractor muscle was observed to be connected with it.

"The nervous system consists of two pairs of ganglia, of which the upper are by far the larger and give off the stout nerve-cords. The cords stretching backwards on either side unite with one another above the rectum at the hinder end of the body. The nerve-ganglia are shown enlarged in fig. 3 (= fig. 30). No sense-organs of any kind were detected. On the outer margin of the large superior ganglion (fig. 3) a series of elongate pellucid cells were arranged side by side perpendicularly to the curved surface which they form. Abundant fine nerves were given off from the entire length of the nerve-cords to the surface of the body, the muscles, &c., arising both from the inner and outer margins of the cords. At the origins of these nerves from the cords there are very slight swellings on the margin of the cord, but these do not contain any nerve-cells. The nerves are very fine, hyaline, with a nearly rectilinear course, and they generally divide into two near their points of distribution; they are never tortuous or much ramified. Terminal organs on the surface of the body in connection with the nerves were carefully sought for but could not be found.

"A pair of vascular trunks follow the course of the nerve-cords through the body, lying internally to them and beneath them. The vessels unite with one another posteriorly, as do the nerve-cords; their course is undulating. Just behind the nerve-ganglia the vascular trunks are enlarged into wide reservoirs. No branches of these vessels were seen, and though the animal was living when examined, no pulsation in them was observed. The vessels had a pellucid wall, in which were imbedded elongate oval nuclei (fig. 4, *b* = fig. 28), but which otherwise appeared structureless. No motion of any fluid within the vessels was seen.

"Although the specimen under description was evidently so immature, well-developed ovaries were present, the specimen being a female, as was the adult one before obtained. The ovaries follow in their disposition the vascular trunks so closely as to appear as if connected with them. The ovaries are simple ovoid sacs with a distinct wall (fig. 2 = fig. 31), filled with ova (in various stages of development) and granular matter. A dark irregular fissure appeared on the centre of each ovary as viewed from the dorsal surface, which I believe to be an opening by which the cavity of the organ communicates with the exterior, thus dorsally. The ovaries were not quite regular in disposition, an extra anterior one being developed on the right side of the body. In the interspace between the most anterior and larger pair of intestinal diverticula and the next posterior pair were four pairs of ovaries, whereas in the succeeding corresponding interspaces were only single pairs of these organs. In the adult specimen described in the 'Annals' (March 1875) a single ovarian sac only was present in each interspace between the diverticula of the digestive tract. It would therefore seem probable that on further development three pairs of diverticula would have budded out between the first and second pairs in the present specimen.

"The muscular system consists of a series of excessively fine transversely or circularly disposed fibres, which are external in position to a series of broad band-like longitudinal muscles. The longitudinal muscular bands are in close relation with the proboscis-sac. Their exact disposition was not made out, and their arrangement, as shown in the figure, will possibly need correction.

"On the whole, *Pelagonemertes* is a form of considerable zoological importance. In the flattened form of its body, and in its dendrocœlous digestive tract the animal resembles Planarians. Amongst the Rhabdocœles the *Prostomeæ* possess an exsertile proboscis like that of Nemertines, but such an organ is present in no Dendrocœle. In all particulars—in being unisexual, in the simplicity of the generative organs, in the form of the nervous and vascular systems and of the proboscis, in the position of the mouth and presence of an anus—in all essential structures *Pelagonemertes* is most distinctively a Nemertine. Only in its remarkable dendrocœle intestine does it differ from all other Nemertines, and (but this is of far less importance) in the modification of its tissue into the peculiar hyaline gelatinous condition which is characteristic of so many otherwise most widely differing pelagic animals.

"The development of the dendrocœle intestine is very remarkable, in that the lateral ramifications are apparently to be regarded as a series of buds occurring successively from before backwards from a previously straight digestive tract, such as exists in other Nemertines. In this the digestive tract differs entirely from that of dendrocœlous Planarians, such as *Leptoplana tremellaris*, in which, as we know from the observations of Keferstein ('Beiträge zur Anatomie und Entwickelungsgeschichte einiger Seeplanarien von St. Malo,' Abhandl. der k. Gesellschaft der Wiss. zu Göttingen, 4ter Band, Göttingen, 1868, Taf. iii. figs. 19, 20, 21, text p. 34), 'the great yelkballs arrange themselves in the embryo with regularity and map out the form of the future digestive tract,' the peripheral ramified part of the tract being formed at the same time as the central portion.

"The peculiar form of the front of the body of *Pelagonemertes* may be regarded as an instance of the excessive formation of the head lappets of many Nemertines. In having no ciliated sacs and an unarmed proboscis, *Pelagonemertes* resembles *Cephalothrix*, but the animal must evidently be placed in a new family of Nemertines, for which I propose the term Pelagonemertidæ, thus characterised :—

"Animal pelagic in habit. Body gelatinous, hyaline, broad and flattened. Proboscis unarmed. Ciliated sacs absent. Special sense-organs absent. Digestive tract dendrocœlous.

"The occurrence of a second specimen of *Pelagonemertes* off Japan shows that the animal has a wide distribution. It was found on both occasions adhering to the trawl-net, and is, from its very slight consistency, easily overlooked. Hence it may have been often missed by us, and probably is as widely distributed as other oceanic forms. Since it has never been taken by former observers of pelagic animals nor by us in the tow-net, it is very probable that it occurs only in deep water, and does not come to the surface ; it is, however, most evidently not an inhabitant of the sea-bottom.

"*Postscript.*—Since the above was written, my attention has been directed by Dr. von Willemoes Suhm to Lesson's original figure of *Pterosoma* in the 'Zoology of the Voyage of the Coquille' (which work we have been able to consult, with a splendid series of similar publications, in the Hawaian Government Library at Honolulu), and to the many points of resemblance between *Pterosoma* and *Pelagonemertes*.

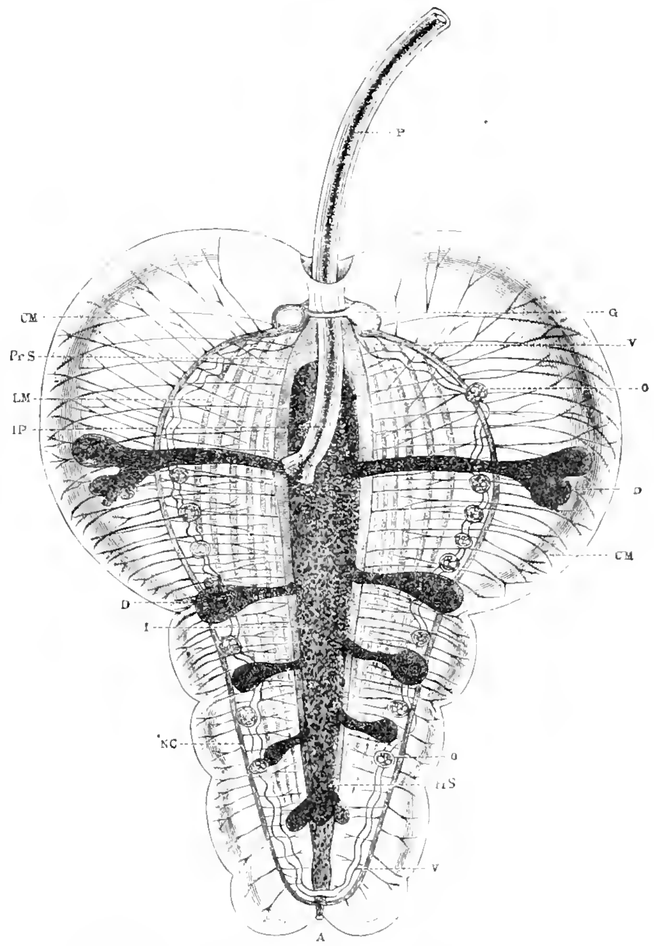

FIG. 3.—*Pelagonemertes rollestoni*, Moseley, enlarged, viewed from the dorsal surface; the proboscis is partly extruded. P, proboscis; PrS, sac of proboscis; IP, invaginated portion of proboscis within the proboscis-sac; G, superior nerve-ganglion; NC, nerve-cords; V, vascular trunk (the upper V points to an enlargement of the vessel lying just posteriorly to the superior nerve-ganglion); I, intestine; D, diverticula of intestine; O,O, ovaries; CM, circular muscles; LM, longitudinal muscles.

"*Pterosoma plana* is described by M. Lesson, 'Voyage de la Coquille, Zoologie,' Paris, 1830, p. 254, and figured, pl. iii. figs. 3 and 3 *bis*. *Pterosoma* was obtained in great abundance by Lesson between the Moluccas and New Guinea, August 31, 1828.

"The animals measured 3 inches and some lines in length, 18 lines in breadth, and 3 to 4 lines in thickness. In general form and gelatinous structure *Pterosoma* resembles

Pelagonemertes further, in that a series of polygonal areas are marked out on its surface. The spirally wound organ, described as a tube, which is indicated in the figure of *Pterosoma*, can scarcely be anything else than the proboscis of a Nemertine, the mouth, at the extreme end of the body, being probably the aperture of the proboscis-sac, and the fusiform nucleus the sac itself. On the other hand, it is difficult to conceive that Lesson, with a number of specimens available for examination, could have missed seeing the very conspicuously burnt-sienna-coloured ramified intestine of *Pelagonemertes* had such been present in his *Pterosoma*. Further, in *Pterosoma*, a pair of elongate, closely opposed eyes are described and figured, having transparent coloured corneæ.

"On the whole, now that a pelagic Nemertine is known to exist, there seems little doubt that the animal seen and figured by Lesson was a Nemertine and not a Mollusc, but it seems to have been a distinct form, with a pair of eyes and an unbranched digestive tract."

For the sake of facilitating reference to Lesson's two figures of *Pterosoma*, in which Moseley is so strongly inclined to see a second species of pelagic Nemertine from the tropical seas—a supposition in which I entirely concur—I have reproduced these on Pl. VIII. figs. 1, 2.

The single available specimen of *Pelagonemertes*, when it came into my hands in September 1884, was no longer entire, but consisted of two fragments of the body, and of three small fragments of the proboscis. Both body-fragments were slit open on the ventral side, the internal surface of the digestive tract, and partly that of the proboscidian sheath, having thus been laid bare. The terminal portion of the body was missing (*vide* Moseley, *supra*). My friend Professor M'Intosh, who made these incisions and examined the specimen before it came to me to be sectionised, has made the following notes:—

"The structure of the cutis corresponds with that of other forms. In the preparation the transparent gelatinous basis-substance for the most part alone remained, the granular cells and clear mucous or gelatinous contents of these spaces having escaped. Beneath this layer is a remarkable deep investment of basement tissue, which forms an elastic investment all round the body. Numerous ducts, often having a zig-zag appearance, pass through this coat.

"The muscular layers of the body-wall, as Professor Moseley observes, are comparatively thin. The external circular fibres are hardly to be distinguished in ordinary transverse sections, and form a thin layer outside the longitudinal. Such a condition contrasts strongly with the well-marked circular coat in *Amphiporus lactifloreus*. The longitudinal muscular coat is likewise comparatively thin, though it is better developed than the circular.

"*Proboscis*.—In the preparation the proboscis is partly extruded, and issues in the same manner as in the ordinary form. It is streaked by longitudinal lines externally.

"In minute structure the anterior region quite corresponds with the typical form, presenting externally a layer of elastic fibrous tissue, which in transverse section presents a series of circular fibres. The external longitudinal muscular coat is well developed. The reticulated layer cuts the foregoing layer into sections, as usual in most other forms, and the connecting bands seem to be broad, the longitudinal belts rounded in transverse section. The condition of the specimen, which is imperfectly preserved, however, probably causes this layer to be more prominent, and the separation between the two longitudinal coats wider. The inner longitudinal muscular coat has the usual thickness and appearance, and the same may be said of the inner circular muscular coat. The basement layer is very largely developed, and fills up a considerable part of the central area. It is somewhat regularly streaked by a radiating series of granular channels. Occasionally tortuous and numerous granular cells occur in it. The central granular glandular tissue has mostly disappeared, but in minute structure it corresponds with that in other forms.

"The middle region of the organ presented no visible stylets, but otherwise it agrees in general configuration with the typical form, though less definitely formed. The glands of the posterior region are largely developed.

"The posterior part of the proboscis sheath had a quantity of flocculent material microscopically presenting numerous granular, and often nucleated cells, mixed with granular material; such might be connected with the proboscidian gland.

"The mouth, as Professor Moseley observes, forms a well-marked aperture with a frilled margin. It is proportionally the most distinct aperture yet observed. The minute structure of the œsophageal region is similar to that of other forms, and it terminates similarly.

"The dendritic arrangement of the digestive system, Professor Moseley states, is the most remarkable feature about *Pelagonemertes*, indeed it differs from all other Nemerteans. The condition of the organ in the other forms, however, renders the arrangement less striking. In *Nemertes gracilis*, for instance, it is considerably divided. Microscopically it agrees with other forms in cells, &c. Professor Moseley describes a distinct anus in the young form, but the specimen may have been incomplete posteriorly. It is certainly unusually distinct. The vascular system offers no particular feature of interest so far as observed, and seems to follow the ordinary arrangement. The lateral vessels appear to vary a little from the ordinary relation to the nerve-cords, being often internal rather than inferior, but probably such is due to the yielding nature of the tissues. The inner lining of the vessels is granular, and a few granular cells appear in the centre, but the nature of such is problematical. . . . .

"The nerve-trunks are enveloped in a coating of nerve-cells. The branches from the ganglia and nerve-cords are remarkably distinct, presenting a clear sheath and granular axis cylinder. The gelatinous interstitial substance extends between the muscular substance and fills up the central area of the body in transverse section to an unusual extent, as pointed out by Professor Moseley.

"Besides the organs mentioned by this author within the body-cavity, a large number of granular nerve-cords run outwards to the surface (muscular wall), besides fine fibres, which are very apt to assume a coiled or zig-zag appearance. Some of these much resemble blood-vessels, but they are probably nerves, and they divide into fine branches towards the muscular coat.

"The proboscidian sheath or chamber is very large, and its anterior aperture would seem to be unusually distinct. The structure of the parts in unrolling of the organ is the same as in the others, and the wall of the chamber presents continual circular internal longitudinal fibres; the posterior region of the proboscis is firmly fixed as usual to the internal wall of the proboscidian sheath at its narrow posterior end. The fibres of attachment are short, so that the *cul-de-sac* of the posterior chamber is brought close to the surface of the wall of the sheath. From the appearance of the parts posteriorly, it is possible that the region is in process of repair after laceration. Indeed, it is not unlikely that both anterior and posterior ends can easily be repaired after rupture, and that might account for the absence of eyes (see Lesson's *Pterosoma*, 'Voyage of the Coquille'). Such gelatinous forms are especially prone to rupture, and sufficient is known of the recuperative power of the Nemertean to render repair rather than permanent injury the rule. The proportionate size and firmness of the proboscidian chamber, with its glistening internal surface, are certainly remarkable, and, on the whole, my impression is that the form is incomplete posteriorly."

All the fragments of *Pelagonemertes* that came into my hands were carefully treated with staining reagents, hardened, imbedded and sectionised. The sections were all transverse. Pl. VIII. fig. 3 represents one of the average sections with parts of all the important organs imbedded in the common gelatinous basis. No sufficient sections of the brain were available, nor were distinct traces found of a nephridial system. The integument was in most parts of the surface wholly deficient; in a few others its general correspondence in transverse section with what is typical for the Hoplonemertea could be verified.

Certain other striking particulars, also visible in this section, and on the whole only confirmatory of what we already knew by Moseley's and M'Intosh's observations, are (1) the absence of a dorsal median blood-vessel; (2) the ventral openings of the generative sacs; (3) the numerous transverse fibres, both contractile and nervous, running in different directions through the body-jelly. Further, it may be observed, even with a rather low power, that each of the ripe ova is surrounded by numerous small follicle cells (Pl. VIII. figs. 3, 11), and that the nucleolus is often only represented by very numerous small chromatin spheres.

By the aid of stronger powers the details also represented on Pl. VIII. by figs. 4–13, can be more fully studied, and of these mention will successively be made in the different paragraphs, which are more especially devoted to the internal anatomy of the different representatives of the species, that are here described in their systematic arrangement.

C. SCHIZONEMERTEA.

Family LINEIDÆ.

Cerebratulus, Ren.

To this genus I wish to refer all the Schizonemertea collected by the Challenger. I have elsewhere (VIII) insisted on the difficulty of distinguishing the genera *Cerebratulus*, *Lineus*, *Micrura*, *&c.*, of which perhaps the two first may be distinguished by an ontogenic difference (*Pilidium* or *Desor*-larva). And even this distinction is not definitely established. It is simply impossible to refer spirit specimens to any one of these genera rather than to any other, and having formerly included *Micrura* as a synonym amongst *Cerebratulus*, I now even feel inclined to do the same with *Lineus*. What value has a generic distinction when it can never be of any use to a taxonomist? And why should a developmental difference, such as that which obtains between a *Pilidium* and a *Desor* larva, not be sufficiently honoured by a specific distinction?

As to describing new species in this genus, it is even more difficult than in any other, because of the number already existing, which are partly solely distinguished by their coloration in life, a character not available in determining the Challenger specimens. Hence, only in seven cases can I hold myself justified in referring the fragments to separate species, six of which are new. The remaining fragments and heads, which clearly show the *Cerebratulus* type (*e.g.*, Pl. XV. fig. 8), I will not specifically distinguish; what remarks I have to make about them will appear when treating of the anatomy, and will then be noticed as pertaining to the genus *Cerebratulus* in general.

Following the order of succession of the stations at which the Schizonemertea were successively dredged during the expedition, we will now proceed to describe them.

Cerebratulus truncatus, n. sp. (Pl. I. figs. 11, 12).

This species, collected on the coast of Nova Scotia, and, as we refer a specimen from Bermuda to it, also frequenting the ocean in the vicinity of those islands, was captured May 8, 1873 (Le Have Bank), and once more, on May 20 of that year, when it came from a depth of 85 fathoms at Station 49.

The anterior part of these two specimens is figured on Pl. I. figs. 11, 12, the first being a side view, the second a ventral view, the latter more considerably, the former about four times enlarged. From both figures it is seen that the mouth is small and close to the tip of the head, which is more or less truncated, that the cephalic slits are comparatively short, extending on to the anterior surface of the head, where they do not, however, coalesce, but leave a small interval in which the proboscidian aperture is situated.

This is all that can be said of the external appearance.

The internal structure further confirms the supposition which the external characters point to, viz., that these two specimens belong to the same species. Thus, certain chief points in the series of transverse sections made through both the specimens coincide to a degree that may be judged of by the following table:—

	In Specimen *a*.	In Specimen *b*.
The superior brain commissure is situated in section No. .	30	34
The inferior brain commissure is situated in sections No. .	35–39	38–44
Canal of the posterior brain lobe is situated in section No. .	43	51
The mouth begins in section No.	55	60
The mouth ends in section No.	84	103
First appearance of nephridia in section No. . . .	97	112

In specimen *a* (May 8, 1873) there are noticed four transverse deferent ducts to the longitudinal nephridial duct on the left side (in sections 138, 175, 217 and 278), and four on the right side (sections 147, 191, 217 and 278).

In specimen *b* (May 20, 1873) there is a less regular arrangement, some of the deferent ducts being double, *i.e.*, two at the same level or in the same section. Once in this specimen this is so arranged that in the one section (No. 197) there are four deferent ducts cut nearly throughout their whole length. In the portion of the œsophageal region sectionised, which, however, does not embrace the whole nephridial region, I count in this specimen on the left side six deferent ductules (sections 112, 144, 156, 159, 197, 207), and to the right also six, which are only partly opposite to the left ductules (sections 142, 168, 178, 180, 197, 208). In judging of this apparent discrepancy it should not be lost sight of that the short distance separating the two ductules 156 and 159 on the left is still symmetrically repeated on the right side in 178 and 180, though somewhat further backwards.

A commissure uniting the two vagus nerves after they have left the brain and before they have yet reached the œsophagus was distinctly noticed.

The histological details of the integument fully correspond to the type of *Cerebratulus corrugatus*, which will hereafter be more fully described and figured (*cf.* Pl. XIII. fig. 6), and which is diagrammatically represented in fig. 9 of Pl. XI. as differing from figs. 10 and 11.

One of the specimens showed a very curious pathological degeneration, which I will however, only touch upon very briefly. The muscular tissue on a restricted but ring-shaped region not far behind the head, and only as far as the circular and longitudinal muscular coats are concerned, is replaced by (or gradually passes into) a homogeneous gelatinous mass, in which granular spherical bodies with large and distinct nuclei (about one-fifth of the diameter of the body-wall on this spot) seem to be suspended. Is this a local injury? Are these bodies enclosed gregarines or other parasitical unicellular organisms?

These questions can as yet only be formulated but not answered, and I would call the attention of future observers dealing with fresh material to similar cases, which no doubt must be accompanied by some externally visible distinction between the tissues.

Of the Bermuda specimen, which I refer to this species only with doubt, and which measured 33 mm. in length by $2\frac{1}{2}$ mm. in diameter, the integument was very imperfectly preserved; still it corresponds in the remaining characters with the other specimens of *Cerebratulus truncatus*. There are also points of agreement in the structure of the proboscidian sheath.

The transverse blood-vessels are very thick-walled in this specimen, a feature more particularly due to the basement-tissue below the inner epithelial lining.

Cerebratulus medullatus, n. sp. (Pl. XI. fig. 10; Pl. XII. figs. 9, 10).

It is hardly consistent with the most lenient rules of zoological nomenclature, and it is certainly not consistent with those which I have myself advocated in my introduction, to establish a new species on a fragment which has neither head nor tail! Still, as I have been rather careful on other occasions, and that especially with regard to genera, I may be trusted to be anxious to guard against superfluous additions to an already cumbersome synonymy. The reasons by which I am guided in putting up this mutilated spirit fragment as the type of a new species are purely morphological, and, as will be seen in the paragraph treating of the nervous system, the peculiarities offered by this species are of sufficient morphological interest to give it a place by itself, and (in at the same time naming it) to direct the attention of collecting naturalists to this form.

It came up in the same haul of the dredge as did one of the specimens of *Cerebratulus truncatus* just described, viz., at Station 49, off Nova Scotia, from a depth of 85 fathoms.

In sections it is, however, immediately seen to be distinguished from the foregoing species by several features, the first of which concerns the integument. Instead of the integument being separated from the longitudinal outer muscular layer by a more or less massive expanse of basement-tissue (Pl. XIII. fig. 6), the integument itself being divided into a superficial and a deeper glandular layer (which are separated by a secondary basement membrane and an expanse of fibres, such as is found in *Cerebratulus corrugatus*, *Cerebratulus truncatus*, &c., also in the Challenger collection), our present species has the superficial layer of the integument immediately applied to the outer longitudinal muscles, from which it is thus only separated by the outer secondary basement layer just alluded to (Pl. XII. fig. 10). This fact causes the integument in transverse sections to appear very thin in comparison to that of other species. However, closer inspection reveals (as will be more fully discussed in the paragraph devoted to the integument) that the deeper glandular layer is not wholly deficient, that it has only become intercalated amidst the outer longitudinal muscular layer, which in this species is not very massive, and that its cellulo-glandular elements thus reach amongst these muscle fibres, even as far down as the nervous layer just outside the circular muscular coat (*cf.*, Pl. XII. figs. 2, 10). The strong affinity which these gland-cells possess for staining reagents brings this out in the sections very clearly.

Nor is this the only distinctive feature of *Cerebratulus medullatus;* the second, and none the less important, is that in the nervous plexus just alluded to, the dorso-median longitudinal thickening, which I shall presently, in the anatomical part of this Report, designate as the medullary nerve, is exceptionally massive (*cf.*, Pl. XI. fig. 10 ; Pl. XII. fig. 9), being about one-third to one-fourth of the thickness of the fibrous core of the lateral longitudinal nerve-trunks. Amidst the fibres of this dorso-median stem a few nuclei, more faintly coloured and marking the presence of nerve-cells, are also seen.

In longitudinal sections through the same specimen, the unusual size, distinctness, and marked individuality of this nerve-stem was also very obvious.

No other features of this species will for the present be enumerated. The specimen on which it is founded was of the female sex.

I sincerely hope that the points here enumerated may enable American naturalists, when recapturing specimens of the species, to recognise it and to give us indications of its colour and other peculiarities in life, of the shape of its head and cephalic slits, and of its brain lobes and proboscis.

Cerebratulus longifissus, n. sp. (Pl. I. fig. 16 ; Pl. XV. figs. 1, 9, 10).

No other Schizonemertea were collected between the last-mentioned station and Marion Island (Station 144A). A *Cerebratulus* was here brought to light, which it will in future be easy to recognise by the fact of its having uncommonly long cephalic slits. The specimen, which was perfect, and is also characterised by its comparative shortness, is figured on Pl. I. fig. 16. On inspecting it with the naked eye the mouth was found to be small and to be situated anteriorly ; the proboscidian aperture occupied the place indicated in the figure, whereas on the dorsum of the animal, just behind the end of the slits, two rows of sublateral, very small pores were noticed, being visible as extremely small white punctures. These rows were continued very far backwards. Although, on account of their reaching so very far forwards, they might at first sight be taken for the exterior openings of the nephridial system, the sections showed that they are indeed the generative pores. Moreover, that the cephalic slits, though long, are comparatively shallow, especially in their posterior portion, and that the canals leading into the posterior brain-lobes do not open out in the lower angle of the fissure but far forwards, in agreement with the situation of those lobes.

It will perhaps best serve the purpose of conveying an idea of the relative situation of the more important organs in the head and trunk to give, as was done for the foregoing species, the number of the section of the whole transverse series (into which head and anterior œsophageal region were cut up) in which these organs occur.

We then find:—

Section 30. First appearance of the lateral blood-lacunæ in the head.
Sections 64–66. Superior commissure of the brain-lobes.
Sections 71–78. Inferior commissure of the brain-lobes.
Section 80. Left canal from cephalic fissure into posterior brain-lobe.
Section 87. Right canal from cephalic fissure into posterior brain-lobe.
Sections 84–104. Left posterior brain-lobe.
Sections 89–105. Right posterior brain-lobe.
Section 71. The median blood-vessel enters the proboscidian sheath.
Sections 350–360. It again leaves it.
Sections 129–159. Mouth.
Section 129. First appearance of the nephridial canals just above the level of the longitudinal nerve-trunk.
Sections 355–400. Left deferent ducts of nephridial system.
Sections 329–335. Right deferent ducts of nephridial system.

These two deferent ducts (the only pair) are seen in the same section which still shows the cephalic fissures. The ducts do not, however, open out into these fissures, but just above them. This also proves how far the fissures reach, all along the œsophageal region. In the 410th section the end of the cephalic fissures may be said to be reached, the whole of the nephridial system, excretory ducts and all, being thus situated within the region of the fissures.

Another specimen from the same locality was without a head, and though the principal points of comparison are thus deficient, I feel confident, by the internal characters which are shown by the sections, that we may look upon this specimen as belonging to the same species. It was exceedingly well preserved and showed certain interesting points with regard to the generative organs, which will be more fully discussed in the paragraph devoted to those parts.

Another feature by which the species is—if not distinguished from its neighbours—at least characterised as far as the fragments allow us to judge, is the great thickness of the transverse connecting vessels between the medio-dorsal vessel and the two lateral ones.

Cerebratulus corrugatus (M'Intosh), Hubrecht (Pl. I. fig. 17; Pl. XI. fig. 9; Pl. XII. figs. 3, 4; Pl. XIII. figs. 1–6; Pl. XIV. figs. 2–4).

This species, which was first described by M'Intosh in the Transactions of the Royal Society for 1879 (extra vol., p. 262), has again been recognised by this author as occurring amongst the Challenger Nemertea. I have already indicated (p. 37) why I wish to bring it under the genus *Cerebratulus*, rather than under *Lineus*, where M'Intosh placed it.

The following notes were made by him concerning the Challenger specimens.

"Dredged in considerable abundance in Royal Sound, Kerguelen, January 27, 1874, in 25 fathoms.

"Stat. 149, off Christmas Harbour, Kerguelen, 120 fathoms, small specimens.

"Stat. 151, off Heard Island, 7th Febr. 1874, 75 fathoms. Some reach the length of 200 mm., and much contracted forms have a diameter of about 15 mm. In the œsophagus of one was a blackish mass of sand-grains, sponge-spicules, Diatoms, and mud."

In M'Intosh's previous publications the description of *Lineus* (*Cerebratulus*) *corrugatus* contains the following characteristic features:—

"Body rather abruptly pointed anteriorly, and more gradually posteriorly. The œsophageal region is marked externally by a series of prominent and somewhat regular rugæ, which sweep from the mouth dorsally and ventrally.

"Colour dark olive throughout, with the exception of a white band, which crosses the anterior border of the snout, and passes backward to the posterior third of the lateral fissure, where it bends dorsally and terminates."

"The special characters are the very large mouth, with the prominent rugæ, which show that the animal probably possesses unusual powers of œsophageal protrusion—a supposition borne out by the great development of the external circular muscular fibres, the dorsal longitudinal coat, and the other fibres of the organ. The internal glandular lining is also very firm."

A couple of figures are added, one a section of the proboscis, the other a section of the ventral body-wall. The latter should be compared with our fig. 6 on Pl. XIII. It will then be seen that M'Intosh's "pigmentary layer, divided by a definite black band," is our superficial and deeper layers of the integument (*Isg* and *Idg*). The "black band" between them is no other than our external secondary basement membrane. What M'Intosh designates as the "curious translucent stratum cut into somewhat regular spaces" is our basement layer proper (*B*), comparable to that of *Eupolia* and *Carinina*, and radially traversed by bundles of contractile and nervous fibres, which bring about the "regular spaces" alluded to.

On the whole, our two figures will be seen to correspond very well, only M'Intosh omits the nervous layer and the innervation of the œsophagus. The large mouth and folded lips were very conspicuous in the Challenger specimens, the head of one, seen from the ventral surface to show the mouth, being figured on Pl. XIII. fig. 5.

The different series of sections which I have made through four specimens of *Cerebratulus corrugatus* were very instructive in several respects, although they all conform to the well-known Schizonemertean type. It is especially the considerable development of basement tissue of the integument (Pl. XIII. fig. 6, *B*), which not only brings out the distinction between the outer longitudinal muscular layer γ and the integument much more clearly than is so often the case in other Schizonemertea, where these two have become blended, but which also enables us to trace the course of radial nerve-fibres coming from the plexus or the longitudinal stems, and innervating (after having traversed the muscular layer γ and this basement tissue) the glands and sense-cells of the integument. *Cerebratulus corrugatus* is, moreover, the species in which, for this reason, I was able to determine the direct part which the longitudinal nerve-trunks take in the innervation of the skin (Pl. XIV. fig. 2), whereas, even in this very favourable specimen, I never noticed the faintest trace of a similar participation of nerve-branches directly springing from these stems in the innervation of the subjacent musculature. In that case such branches would have to take an opposite course, and would have to traverse in the first instance the circular muscular layer β. This was never observed. It will be seen in the paragraph more especially treating of the nervous system, as well as in the chapter devoted to general considerations, that this fact is, in my opinion, not without morphological importance.

The specimen of *Cerebratulus corrugatus* is also of great importance in demonstrating the relation of the medio-dorsal medullary nerve and the branches springing from it at right angles as so many thickenings of the plexus (Pl. XIII. fig. 2).

Cerebratulus parkeri, n. sp. (Pl. XIV. fig. 5; Pl. XV. figs. 5, 16).

A well-preserved specimen of a Schizonemertean was collected in the New Zealand waters, which, I think, may safely be looked upon as belonging to a distinct species.

I have dedicated this species to the naturalist who of late years has done so much for our knowledge of the New Zealand fauna, and whose anatomical preparations and zoological collections from those regions have excited the admiration of visitors to the Colonial and Indian Exhibition of 1886.

The head and anterior body fragments of *Cerebratulus parkeri* are thus described in M'Intosh's preliminary notes:—

"A fragment of the anterior portion, measuring about 34 mm. in length, and about 7 mm. in diameter at its flattened and widest region. The cephalic furrows and mouth conform to the ordinary type. The body is somewhat rounded anteriorly; flattened towards the posterior end of the fragment.

"Transverse sections of the rounded anterior region show that the muscular walls of the body are greatly thickened . . . . the longitudinal muscular fibres form a very thick coat all round, especially, as usual, opposite the nerve-cords. . . . . The circular muscular coat is uniformly thick, the longitudinal layer within it being excavated superiorly by the large channel for the proboscis, and laterally by the very large and very muscular vascular canals—a little below each nerve-trunk. The thickened part of this coat is just beyond the proboscidian canal, while the thinnest part is in the median line above it.

"The proboscidian sheath has a remarkably thick wall, which is chiefly composed of an interwoven circular coat, presenting an irregular looped appearance in transverse section. The fibres in thin sections seem to anastomose. On the inner surface of this coat are some longitudinal fibres, with a glandular epithelial coat internally.

"Posteriorly the body-cavity is greatly dilated by the presence of a vast series of ova, so that all the muscular coats are much thinned, and the digestive canal contracted. The inner longitudinal coat is especially affected, three thickenings only being left, viz., one on each side of the proboscidian sheath, and one in the middle line ventrally. The ova are compressed into various angular forms, between vertical partitions which occur at short intervals in the region, and which fill up the entire area, except the small space for the proboscidian and digestive canals superiorly."

For some farther particulars concerning this species, I refer to the description of *Cerebratulus macroren* that is still to follow, and where the points of agreement and of difference between these two evidently closely related species will be more fully entered upon.

A second specimen, also from the New Zealand waters, shows that the conspicuous development of the secondary basement layer of the integument, and the considerable thickness of the medullary nerve, are further characteristic features of this species.

Cerebratulus angusticeps, n. sp. (Pl. I. fig. 15; Pl. XIV. figs. 1, 6; Pl. XV. fig. 4).

This is another Schizonemertean from the New Zealand waters (Station 167A, Queen Charlotte Sound, June 27, 1874; 10 fathoms). Its head is figured on Pl. XV. fig. 4. In M'Intosh's preliminary notes this fragment is referred to in the following words:—

"A fragmentary form, resembling in shape *C. angulatus*, and with an acutely pointed snout. The diameter of the widest flattened region is about 4·5 mm. The colour is dull yellow, with a darker stripe down the middle of the dorsum. . . . . The vascular trunks lie opposite the nerve-cords, and this in the angular lateral region. The external longitudinal muscular coat is largely developed, and the fibres are uniformly fine. The very much produced lateral angle of the body is mainly composed of this coat. In such forms the lateral nerve-cord seems to be much flattened from above downwards."

The sections which I made of this fragment, horizontally through the head and transversely through the trunk, were in many respects very instructive. To the flattened and pointed shape of the head they added an internal distinctive feature of the species in the unusual size of the posterior brain-lobes, which, although in intimate connection with the superior brain-lobes in the same way as in the Schizonemertea, in general equalled or even surpassed the latter lobes in length. Pl. XIV. fig. 6, gives a representation of this, illustrating, at the same time, how in a horizontal section the blood-space (*c.o.l.*)

surrounding the œsophagus may very evidently be seen to be in direct connection with that in the head—a fact known to Blanchard, and for the first time fully described by Oudemans (*loc. cit.*), but never adequately figured. This figure, at the same time, demonstrates the projection of the posterior brain-lobe into this blood-space, by the contents of which it is thus bathed.

Another figure reveals how the sections of *Cerebratulus angusticeps* were important in another respect, viz., that of the medio-dorsal medullary nerve and the transverse branches springing from it in metamerically arranged pairs (Pl. XIV. fig. 1). Nor was this regularity exceptional in the region figured; it was characteristic wherever these transverse nerve-tracts (which will be discussed more fully in their relation to the plexus in the special paragraph) were met with, and was thus equally distinct ventrally and dorsally. Ventrally, however, there is no median longitudinal stem.

On the other hand, the transverse tracts in *Cerebratulus angusticeps* may be traced as high up as the lower brain-lobes, which they connect till just behind the strong ventral commissure of these lobes.

These transverse commissural trunks are distinctly separate from those by which the two stems of the vagus nerve are united close to their origin and in front of the mouth. The latter (*cf.* Pl. XIV. fig. 5) are also present as distinct commissures in *Cerebratulus angusticeps.*

With respect to the nephridia, which often offer certain points of comparison for the different species, I must state that the anterior part of the longitudinal duct is very distinctly seen in the horizontal sections through the anterior extremity of the body, and occupies its usual position in the circumœsophageal blood-space, whereas its size or its histological details showed no special features. The deferent ducts of the nephridial system were not contained in this section, nor in those made through the remaining fragments of the further portions of the body. They were very probably situated in the intervening part, which was sacrificed by M'Intosh in drawing up his preliminary notes, and I cannot thus state with certainty whether these ducts were single or more numerous, terminal or not.

To *Cerebratulus angusticeps* I must refer another specimen which came up in the dredge at Station 168 from a depth of 1100 fathoms. It was much torn and lacerated (Pl. I. fig. 15), a phenomenon which it would, however, be rash to attribute to the depth from which it was brought up, although the possibility of that being the cause cannot be wholly excluded. The reasons for identifying the specimens with *Cerebratulus angusticeps* are the following, and are deduced from the comparison of the sections:—(1) The length of the superior brain-lobes stands to that of the posterior in the same (uncommon) relations as in the specimen above described; (2) the ventral and parallel commissures of the inferior brain-lobes are similarly very conspicuous; (3) certain histological details of the superior brain-lobes and ciliated canal, and also of the nerve plexus, are identical; (4) the aspect of the rhynchodæum is very similar.

Cerebratulus macroren, n. sp. (Pl. I. figs. 13, 14, 18, 19; Pl. X. figs. 8, 9; Pl. XI. fig. 11; Pl. XII. figs. 1, 2, 7, 8; Pl. XIII. figs. 7–9; Pl. XIV. figs. 7, 8, 11; Pl. XV. figs. 2, 3, 19).

From Japan, at Station 232A, a Schizonemertean has been brought home by the Challenger Expedition, which I was first inclined to regard as identical with *Cerebratulus parkeri*, but which I have reluctantly been obliged to distinguish specifically—reluctantly, because there being no possibility of giving outwardly visible distinctive features of colour or shape, I must indicate an anatomical difference as the principal point of distinction between the two; and all the more reluctantly because of a second specimen, which, dredged at 700 fathoms off New Zealand (Station 169), was identical with the Japan specimen, and differed from its much closer geographical neighbour in this very same point. I could not, however, evade assigning the latter specimen to the species now about to be described, knowing by experience that if the confusion created by the unnecessary multiplication of specimens is often very troublesome, the premature combination under one name of forms that afterwards may be shown to be different is often quite as apt to lead to inextricable confusion, when characters which, as a matter of fact, only belong to one of them, are attributed to both.

About this second specimen M'Intosh's rough notes contains the following passage:—

"A small *Lineus*, presenting the ordinary external characteristics, and of a dull yellowish hue, somewhat brownish on the dorsal surface in front. It was tapered from the snout backwards. The cutis has a simple areolar structure; the gelatinous contents were slowly extruded in the sections after mounting, as cylindrical or clavate, translucent gelatinous processes. The basement tissue is largely developed as a translucent belt all round."

Of the larger specimen from Japan, the head is figured (Pl. I. figs. 18, 19). The cephalic slits are perhaps comparatively a little longer than are those of *Cerebratulus parkeri* (Pl. XV. fig. 5), although the New Zealand representative (Pl. I. figs. 13, 14) is again very similar, even in this respect, to *Cerebratulus parkeri*.

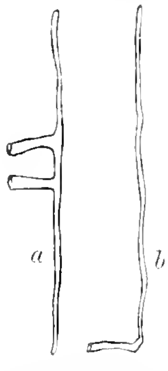

FIG. 4.—Nephridial ducts and their communication with the exterior. *a*, for *Cerebratulus parkeri*; *b*, for *Cerebratulus macroren*.

The internal anatomical character, to which I alluded just now as being a distinctive feature, by which the species differs from *Cerebratulus parkeri*, is the size of the longitudinal nephridial ducts, which are exceptionally conspicuous (both in the Japanese and in the New Zealand specimens), and which have their deferent ducts leading to the exterior situated at the very hindmost end, whereas in *Cerebratulus parkeri* there are two deferent ducts, the one situated very closely behind the other, and placed about the middle region of the longitudinal canal. The accompanying woodcut diagrammatically illustrates this difference between the two species. Oudemans (*loc. cit.*) has already demonstrated that the number of deferent ducts to the nephridial system increases with age; there thus might remain one chance that the New Zealand specimen of *Cerebratulus macroren* could still be assigned to *Cerebratulus parkeri*, if we assume that increase in growth can have brought about a further extension backwards of the principal nephridial duct, and at the same time the appearance of a second deferent duct immediately behind the first. For the present this assumption appears to me to be more strained than my own, which unites the New Zealand and the Japanese specimens by laying more stress upon the large size of the longitudinal tube, combined with the terminal situation of the deferent duct.

The further peculiarities that reveal themselves on studying the microscopic sections, certainly show that the two species, *Cerebratulus macroren* and *Cerebratulus parkeri*, cannot be very far apart. Both have in common the very thick and homogeneous secondary basement layer beneath the outer glandular layer of the integument (Pl. XI. fig. 11).

It would also be difficult to point out salient points of disagreement in the muscular body-wall, the proboscidian sheath, and the proboscis which would hold good when respectively comparing the head, the œsophageal, or the posterior body region.

Cerebratulus, sp. inc. (Pl. X. fig. 7; Pl. XV. figs. 6–8, 18.)

At the close of our systematic description of the Schizonemertea I must mention certain fragmentary specimens, which have all the aspect of belonging to distinct species, but which I cannot venture definitely to unite with any of the species here described, or with such as have been published elsewhere. The fragments here alluded to are mostly without a head, and some of them of not inconsiderable size. I will discuss them in the order of the stations at which they were obtained.

The first was procured in the Kerguelen waters. It is important, in consequence of peculiarities in its integument, which will be more fully discussed in the paragraph devoted to this system. A part of a section was figured on Pl. X. fig. 7, and from that section it may also be gathered that the dorso-median medullary nerve is comparatively very massive. This might eventually prove that it was related to *Cerebratulus medullatus;* the difference in the integument, though important from a morphological point of view, hardly justifying the establishment of a different species, supposing all the other characters, external and internal, might prove to be identical. That difference might then be considered as indicative of a variety.

The second *Cerebratulus*, about which I must remain in doubt, was obtained among the Philippine Islands (off Zebu). M'Intosh has made the following notes about these fragments:—"Fragments of a large species. The fragments in all measure over 100 mm., with a diameter of 12 mm. at the widest part. . . . . The carrying of the vascular trunks far inwards towards the ventral middle line seems to be a feature . . . . in this form."

There were further no particulars, nor any features deviating from the general type of *Cerebratulus* to be gathered from these fragments.

Numerous other fragments, of which one was a head, were obtained at Kobé (Japan). Three of these are figured on Pl. XV. figs. 6, 7, and 8. Sections were duly made of these fragments, but do not give much additional light beyond the general result that we have a *Cerebratulus* before us, which cannot be definitely identified with any of the species hitherto described. The vicinity of the Japanese waters to scientific centres from which accurate descriptions of the Japanese marine invertebrates may probably be expected ere long, makes it all the more advisable to refrain for the present from creating or identifying species from these regions of which sufficient data cannot yet be obtained from the available fragments. Still the specimen figured on Pl. XV. figs. 6 and 7 deserves some attention. The fragment, on which longitudinal and transverse white stripes were visible, as indicated in the figure, was also distinguished by a peculiar rigidity. Transverse sections (Pl. XV. fig. 7) showed that this phenomenon was occasioned, or at all events accompanied by, an extraordinary development of intermuscular gelatinous tissue. The section figured, when compared with that of *Pelagonemertes* (Pl. VIII. fig. 3), will demonstrate this, and at the same time show it to possess the arrangement of muscular layers and other peculiarities that are typical for Schizonemertea. These muscular layers are, however, exceedingly reduced in thickness, and occupy a very inconsiderable fraction of the vertical or horizontal diameter. The proboscidian sheath is, in the fragments investigated, thin and unimportant; in more posterior sections there are indications of its place being taken by more irregularly shaped, cellular material, without a lumen. I am, however, not satisfied with the details that could be gathered from these fragments concerning these important morphological points, and must refrain from more particularly insisting upon them. The transverse blood-vessels are exceedingly numerous and tortuous—the latter phenomenon causing their lumen to be transversely cut a large number of times in every section; these apparent perforations of the gelatinous tissue giving a very peculiar appearance to most of the sections.

Another reason why I do not venture to establish a distinct species upon these peculiar fragments, is the fact that I found them to be very considerably infested by a large unicellular parasite (probably a Gregarine) which was not (as the Gregarines that infest Nemertea generally are) found in the intestine, but which was present in considerable numbers in all the different tissues, both without and within the muscular layers. When surrounded by gelatinous tissue, there was always a well-marked space round the parasite in which it was contained.

There was no distinct capsule, and the free space may perhaps not have existed during the life of both host and parasite. When first noticed, these unicellular parasites, with very distinct nuclei and granular protoplasm, might have been mistaken for ova; not only their distribution throughout the animal as isolated individuals, but also the presence of true ova in the fragments, which proved to have belonged to a female individual, definitely excluded the possibility of any confusion on this head.

The question arises, whether the peculiar appearance of the different tissues recorded above might be pathological, and somehow in causal relation to the infesting parasites. It is this which necessitates extreme caution in the identification of these fragments. I may here remind the reader that another case, presumably of a parasitic organism (also unicellular, but of much smaller size) infesting the different tissues, was met with in *Amphiporus marioni*.

The last fragmentary specimen which I wish to record may, for all I know, have belonged to the common *Cerebratulus marginatus*. It was collected in the Atlantic Ocean, at Station 321, off the Brazilian coast. It was a very large and flattened specimen, but without head or tail. In M'Intosh's notes I find these fragments referred to as follows :—

"Two fragments, respectively 70 and 108 mm. in length, and with a transverse diameter ranging from 21 to 24 mm., the vertical (in the centre) being only 5 or 6 mm. The dorsal surface was dull olive, with a dark median band, the greater part of the breadth being marked by fine transverse striæ, leaving only the borders untouched. Various transverse lines, passing quite across the body, also occurred ventrally. The median line and the borders had each a smooth belt, the rest being marked by the closely arranged and tranverse lines. A median ridge occurred along the ventral band."

The ova of this species, polygonal by reciprocal pressure, and surrounded by a gelatinous outer layer (capsule), are figured on Pl. XV. fig. 18.

LIST OF THE STATIONS AT WHICH THE DIFFERENT SPECIES OF NEMERTEA COLLECTED BY THE CHALLENGER WERE OBTAINED.

Distinguishing No. of Station.	Date.	Latitude and Longitude.	Depth in Fathoms	Nature of Bottom.	Species collected.
45	1873. May 3	38° 34′ 0″ N., 72° 10′ 0″ W.	1240	Blue mud	*Carinina grata.*
47	,, 7	41° 14′ 0″ N., 65° 45′ 0″ W.	1340	Blue mud	,, ,,
...	,, 8	Le Have Bank, N. Scotia	75	...	*Cerebratulus truncatus.*
49	,, 20	43° 3′ 0″ N., 63° 39′ 0″ W.	85	Gravel, stones	*Drepanophorus lankesteri, Cerebratulus truncatus, Cerebratulus medullatus.*
...	June	Bermuda	...	...	*Cerebratulus truncatus, Tetrastemma agricola.*
...	,,	Bermuda to Azores ...	...	Gulf weed	*Tetrastemma fuscum.*
...	July	St Vincent, Cape Verde Islands	...	...	*Eupolia delineata, Drepanophorus rubrostriatus.*
144A	Dec. 26	46° 48′ 0″ S., 37° 49′ 30″ W.	69	Volcanic sand	*Cerebratulus longifissus, Amphiporus marioni.*
149	1874. Jan. 9	49° 8′ 0″ S., 70° 12′ 0″ W. (Accessible Bay)	20	Volcanic sand	*Amphiporus moseleyi.*
149E	,, 21	49° 37′ 0″ S., 70° 16′ 0″ W.	30	Volcanic sand	*Cerebratulus corrugatus.*
...	,, ,,	Royal Sound, Kerguelen	...	...	*Amphiporus moseleyi, Drepanophorus serraticollis, Cerebratulus corrugatus.*
...	,, ,,	Christmas Harbour	...	...	*Cerebratulus* sp. inc. (*medullatus?*), *Amphiporus moseleyi.*
151	Feb. 7	52° 59′ 30″ S., 73° 33′ 30″ E.	75	Volcanic sand	*Cerebratulus corrugatus.*
158	Mar. 7	50° 1′ 0″ S., 123° 4′ 0″ E.	...	...	*Pelagonemertes rollestoni.*
162	Apr. 2	39° 10′ 30″ S., 146° 37′ 0″ E.	38	Sand and shells	*Drepanophorus serraticollis.*
167A	June 27	41° 4′ 0″ S., 174° 19′ 0″ E.	10	Mud	*Cerebratulus parkeri, Cerebratulus angusticeps.*
168	July 8	40° 28′ 0″ S., 177° 43′ 0″ E.	1100	Blue mud	*Cerebratulus angusticeps.*
169	,, 10	37° 34′ 0″ S., 179° 22′ 0″ E.	700	Blue mud	*Eupolia giardii, Cerebratulus macroren, Eupolia australis.*
209	1875. Jan. 22	10° 14′ 0″ N., 123° 54′ 0″ E.	95	Blue mud	*Cerebratulus* sp. inc.
232	May 12	35° 11′ 0″ N., 139° 28′ 0″ E.	345	Green mud	*Cerebratulus macroren, Cerebratulus* sp. inc., *Eupolia nipponensis.*
...	June 5	34° 58′ 0″ N., 139° 30′ 0″ E. off Japan	...	...	*Pelagonemertes rollestoni.*
321	1876. Feb. 25	35° 2′ 0″ S., 55° 15′ 0″ W.	13	Mud	*Cerebratulus* sp. inc.

A glance at the foregoing table shows that the very large majority of Nemertea were captured in shallow water, and that they may, as a rule, be said to belong to the littoral fauna. The most aberrant new types are the pelagic *Pelagonemertes*, and the genus that has come from the greatest depth, *Carinina grata*.

The interesting peculiarity of a strongly developed medullary nerve, which is much less conspicuous in the European species hitherto investigated, occurs in species so widely apart as the waters of Nova Scotia (*Cerebratulus medullatus*), of Kerguelen (*Cerebratulus* sp. inc. (*medullatus?*), of New Zealand (*Cerebratulus parkeri*), and of Japan (*Cerebratulus macroren*).

If we group the species according to geographical distribution, we find as novelties in the American part of the Atlantic—

> *Carinina grata, Drepanophorus lankesteri, Cerebratulus medullatus,* and *Cerebratulus truncatus.*

Off Marion Island :
Amphiporus marioni, *Cerebratulus longifissus*.

Off Kerguelen :
Amphiporus moseleyi, *Cerebratulus corrugatus*.

Off New Zealand :[1]
Eupolia giardii, *Eupolia australis*, *Cerebratulus parkeri*, and *Cerebratulus angusticeps*.

Off Japan :
Eupolia nipponensis and *Cerebratulus macroren*.

It might have been expected that a collection of Nemertea from different parts of the globe, preserved in spirit, would prove to be less valuable for our intimate knowledge of genera and species, and for our elaboration of the systematic arrangement of this group, than it would be for anatomical and histological purposes. Where external specific characters have come to be totally effaced, the details of the internal framework remain most perfectly preserved for microscopic investigation. In the preceding pages we have encountered difficulty in attempting specifically to determine the fragments forming this collection, and we have at the same time seen that only in four cases (*Eupolia delineata*, *Drepanophorus rubrostriatus*, *Drepanophorus serraticollis* and *Cerebratulus corrugatus*) coincident with extraordinarily favourable circumstances, was identification possible with species already known.

That nevertheless new species could be established with certainty must merely be ascribed to the fact that the distinguishing internal specific characters, gathered by means of microtomy, were so marked and so divergent. Still we cannot picture to ourselves the appearance of these new species when alive and in the fresh state.

As just noted, we have in this collection a much more reliable basis for the study of the anatomical and histological details. We must, indeed, recognise that we have to thank the exceedingly well-preserved collection of Challenger Nemertea for several new facts and suggestive results, to the description of which we will now devote a new chapter.

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[1] Mention is made in M'Intosh's Monograph (**XIX.**, p. 96) of a New Zealand Nemertean, distinguished by Baird as *Lineus novæ-zelandiæ*. I have nowhere been able to find any description of this species by that author. After personal inspection of Dr. Baird's specimen, which is preserved under that name in the British Museum, I do not, however, feel justified in identifying with it any of the Challenger specimens from New Zealand. Externally it much more resembles *Cerebratulus corrugatus*, and if this latter species is really encountered in New Zealand, Baird's name will have to be dropped altogether.

ANATOMICAL INVESTIGATIONS.

INTEGUMENT.

By "integument" I wish to designate the cellular layers as they are found outside the more or less stratified connective tissue, which is known as the basement membrane. The latter is of very varying thickness, and, for reasons to be given subsequently, will be treated in another paragraph. Glandular structures of the integument, whether enclosed within the cellular layers just alluded to, or stretching inwards between the muscles and piercing a secondary basement membrane, hereafter to be described, only by means of their communicating ducts with the exterior, will also be treated of here.

Commencing with a description of the integument of the Palæonemertea, it will be well to take the more important genus of which representatives are found amongst the Challenger Nemertea, viz., *Carinina*, as a type. This is all the more desirable as we shall here find the central nervous system still clearly belonging to the integument, its constituents imperceptibly merging into those of the deeper cellular layers of the skin, and also lying outside of the basement membrane.

The two specimens of *Carinina* at my disposal revealed the same features with respect to their integument, although in one of them the granular secretion in the glands that form part of it is much more copious. When we leave out of consideration the basement membrane, that can be easily detected in the sections by the uniform and deep red tint it acquires by the staining reagent (picrocarmine), we can roughly distinguish four constituent strata in the integument not in any way separated by sharp boundary lines, but characterised by the presence of different histological elements which we will now proceed to describe more fully. It will be understood that the absence of fresh material and the scanty supply of spirit specimens has necessarily limited the exact discrimination of these histological elements.

Of the four strata alluded to, the one adjoining the basement membrane is extremely important, being the seat of those cellular modifications which must be looked upon as the differentiation of the central nervous system within the domain of the integument. This position—it was already noticed in the description of the species given above—remains the same in the adult, and we have in this more superficial situation of the central nervous system one of the surest indications of the more primitive position that ought to be assigned to *Carinina* and the allied genera, when compared with the other Nemertea.

The intermixture of integumentary and nervous tissue is none the less evident in the medio-dorsal longitudinal nerve than in the lateral stems. The first named nerve, which in former publications (IX, X) I have, not wholly adequately (*cf.* p. 132), designated as the proboscidian-sheath-nerve, can readily be distinguished in my transverse sections of *Carinina* as a delicate stem. It is not situated, as in the Schizonemertea, just outside the circular and below the outer longitudinal muscular coat, nor, as in *Drepanophorus, Amphiporus marioni*, &c., below the basement membrane just outside the same circular muscular coat, but it lies in this case *actually outside the basement membrane, and forms part of the deepest layer of the cellular integument.* Further, a plexus-like distribution of nervous tissue between dorso-median and lateral nerve-stems obtains in this species, as was more fully described elsewhere for the Schizonemertea, connecting the three longitudinal stems and spreading round the body as a cylindrical investment. It must be remarked that this plexus-like arrangement is thus necessarily situated in the very layer of the integument with which we are occupied, and it may be added, that in numerous transverse sections of *Carinina* the presence of fibrillar nerve-tracts in this layer can be easily demonstrated, and these exactly resemble those that are met with in the nervous plexus of Schizonemertea. This plexus has, since my first notice of its presence (IX, X) been again observed by Dewoletzky (II) and other naturalists, and will be more fully discussed in a succeeding paragraph.

The plexus here alluded to merges into the lateral nerve-stems. I may here once more emphasize the fact that the whole system lies outside the basement membrane. At the same time, however, the lateral stems would seem to be separated, though very incompletely, from the integument by bundles of fibres which bind them down to the underlying layer of circular fibres (Pl. III. figs. 7, 8.)

In the vicinity of the brain-lobes it is impossible to distinguish between the cells of the deepest integumentary layer and the nerve-cells. With respect to this layer I have further to state that its nuclei are less conspicuous, its cells paler, and the boundary lines of the latter less easily distinguished than in the other layers. Extremely delicate fibrillar tracts were already noticed as occurring in it.

The next layer to this, when we pass outwards, is the glandular layer of the integument. It is the thickest of the four, being alone often as massive as the three others taken together. The large, flask-shaped, and tubular glands it encloses contain a thick granular secretion, which is partly stained brownish-yellow, partly dark red in my preparations (Pl. III. figs. 3, 7, 8, *gi*; Pl. IV. fig. 1; Pl. VI. figs. 1–3). The ducts leading to the exterior penetrate the two outermost layers. The presence in the most peripherally situated of the two latter layers of similar though much shorter glandular cells (Pl. IV. fig. 1; Pl. VI. fig. 2, *E*), immediately contiguous with others of a larger size, makes it a subject for inquiry whether these are connected by transitional forms to those larger ones which form the layer we are now describing. This involves the not unimportant question, whether the glands constituting this layer are or are not unicellular. While I am inclined to accept the latter proposition, I feel that the question can only be solved by the aid of a careful inquiry into fresh specimens.

The layer external to the glandular is one in which very numerous and deeply stained nuclei are heaped together. These nuclei occupy several rows in one section. The same may be said to apply, as will be indicated further on, to the corresponding layer of deeply staining nuclei in the integument of the Hoplonemertea.

The very outermost layer bearing the cilia clearly contains, in *Carinina*, the same elements as will be described more in detail (*vide infra*, pp. 58, 61) for the Schizonemertea, *i.e.*, nervous end-cells, alternating with supporting cells, "Stützzellen."

This layer, containing fewer nuclei and less granular protoplasm, is more transparent in transverse sections, and distinguished by fine radial striæ, indicating the boundary lines between the contiguous cells. The four layers here described are not equally distinct in all sections, nor are they equally well marked in all the sections figured. Thus, for example, in fig. 4 of Pl. III. the glandular layer is feebly developed, and the two external layers are so indifferently preserved that their distinctive character, just described, fails to attract attention. The chief points enumerated can, however, even there, be easily ascertained. The partial absence, or, at any rate, temporary indistinctness of these gland-cells in certain portions of the integument can also be observed in tangential sections, such as the one of Pl. III. fig. 8. There, too, the groups of glandular cells to the right and the left are separated by a band of integument, in which they are decidedly absent. The same figure shows the different ways in which the contents of these gland-cells react on staining agents; those to the right in this section have decidedly yellowish contents, whereas the contents of the group on the left had a deep carmine tint.

This description of the integument of *Carinina* must now be followed by that of *Eupolia*, the only other genus of Palæonemertea contained in the Challenger collection. The interesting genera *Carinella*, *Cephalothrix* and *Carinoma*, are not represented in those collections and certain intermediate characters displayed by these genera, which serve to justify the identification of the different layers, which as I am going to propose can only be touched upon as far as they elucidate the phenomena. This I will defer till after the detailed description of the integument of *Eupolia*.

Instead of four layers it would not be difficult to distinguish eight in the integument of this genus, not all of them separately and clearly represented in every section, but sometimes (*e.g.* Pl. VII. fig. 5, 9) sufficiently distinct. This arrangement may be looked upon as a further differentiation of an earlier phase, corresponding to that of *Carinina*, the chief difference being that the basement membrane upon which the whole integument rests, is not here, at least not in all specimens, so clearly defined, nor comparatively so structureless, as it is in *Carinina*, and as we shall again find it in the Hoplonemertea. Moreover, identification is somewhat obscured by the appearance of a second, homogeneous, very thin basement membrane, which has also a strong affinity for the staining reagent, and which we must be careful separately to distinguish, if we wish to establish an adequate comparison between the parts in the different genera. This second basement membrane (*B*, in Pl. VII. figs. 2, 3, 5, 6, 9; *b*, in Pl. XII. fig. 2; Pl. XIII. fig. 6) divides the integument into two strata—an external one, comprising the peripheral sense-cells and ciliated cells, the unicellular glands, and the layer of deeply-stained nuclei; and an internal one, containing the longer and more tortuous glands, the deepest integumentary tissue, and, moreover, at least two very thin layers of fibres.

If we count the thin basement membrane alluded to for one layer, this makes three strata externally and four internally to it—eight altogether.

The different aspects of these strata may be gathered from the figures on Pl. VII. Fig. 6 shows the three layers outside the membrane *B*, and though the histological elements were not isolated, it was very obvious that large unicellular glands were here pouring their secretion to the exterior. The very outermost layer was here, as in all Nemertea, formed of strictly radially arranged cells, with far less distinct nuclei, whereas between and just below the secreting cells strongly stained nuclei give to this part of the integument the peculiar radially striped appearance which it has when viewed with lower powers (figs. 2, 3, 5, 9). This same peculiarity is only less visible in fig. 6 because of the very copious discharge of secretion in the gland-cells. From figs. 5 and 9 it is sufficiently obvious, however, that these glands are not the only ones, but that in the layer indicated by *Gi* the darkly-stained secretion of more deeply lying, larger, and more irregularly-shaped glands is unmistakable, and is also seen to communicate with the exterior by fine tortuous tubes piercing the superposed membranous and cellular strata, about ten of these ducts being specially indicated in fig. 5. Their direct passage into the respective glands is not always visible in one section, the course of the tubes being tortuous. The same glands, though also present in the sections shown in figs. 2 and 3, are there less marked, because the secretion has not yet so distinctly accumulated. Here, too, the reference letters *Gi*, point to the stratum in which we find them imbedded. A second constituent of this stratum is seen in cells similar to the secreting cells in the unripe stage (figs. 2, 3), but having afterwards a very distinctly vacuolated character, and then forming the surrounding and sustaining tissue for the functional glands. They might, then, best be designated as vesicular connective tissue ("blasenförmiges Bindegewebe"), with hardly any intercellular substance. The comparative thickness to which this part of the integument may attain is best understood from Pl. VII. figs. 5, 9, *Gi*. That there is a sharp line of demarcation between it and the gelatinous or lamellar connective tissue of the basement layer *Bct*, upon which the whole of the integument rests, may here be specially insisted upon, and is indicated in the same figures.

Finally, I have to mention the two layers of fibres which, though very delicate, form in *Eupolia* very constant and characteristic parts of the integument. They are immediately applied against the inner surface of the supernumerary basement layer *B*—an outer layer of circular and an inner one of longitudinal fibres. Fig. 9 (*Eupolia delineata*, long. sec.) shows them to be more conspicuous than figs. 2, 3 (*Eupolia australis*). Fig. 9 moreover, serves to demonstrate that the pigment, to which in this species the peculiar longitudinal brown stripes are due, is accumulated in the same stratum of the integument, where these fibrous layers are found; the section represented shows an unpigmented zone between two pigmented ones. The pigment is granular, and appears to be limited to this stratum. It was not met with in the other species of *Eupolia*.

That I am justified in looking upon the integumentary arrangement of *Eupolia* as a higher differentiation of a lower type, which in general resembles the integument of *Carinina*, must now be shown by a short account of the condition of things in *Cephalothrix* and *Carinoma*, two other Palæonemertea, both of them inhabitants of the European seas.

Cephalothrix shows an advance in differentiation upon *Carinina*, by the deeper situation of the lateral nerve-stems (Pl. XI. fig. 15), imbedded in the outer longitudinal muscular layer. Still it deserves special attention, that in this genus the medio-dorsal nerve is still situated *in the deepest layer of the integument* (Pl. XI. fig. 5) outside of the basement membrane, and that, at the same time, the integument wholly answers to the description that we have given of the integument of *Carinina*.

Carinoma, whilst generally agreeing with *Cephalothrix* in the situation of the lateral nerve-stems, no longer retains the longitudinal medio-dorsal nerve as part of the integument, but in a somewhat deeper situation, enclosed in the basement-membrane. It also shows very decided complications in the structure of the integument. Whereas the basement layer is most closely similar to that of *Carinina* and *Carinella*, the outermost integumentary layer is much more distinctly cellular, provided with unicellular glands, and separated from the deeper glandular layer by the development of two layers of muscular fibres that were first noticed by M'Intosh (XXIV), and by him interpreted as two accessory muscular layers of the body-wall. They are such, in fact, although I feel confident that we may look upon them as forming an integral part of the integument, and as being, together with it, wholly of epiblastic origin. Not wishing to give a figure of *Carinoma*, which does not form part of the Challenger collection (the diagrams on Pl. XI. may, however, be consulted), I must needs appeal to the confidence of the reader that a glance at a transverse section of the integument of *Carinoma* carries with it the conviction that it is, in this respect, truly the most conclusive intermediate form between *Carinina* and *Eupolia*, so that we are amply justified (1) in declaring the basement membrane (*B* of Pl. III. figs. 3, 4, 7; Pl. IV. fig. 1) to be not homologous with the one also lettered *B* on Pl. VII., but to be so with the deeper layer, *Bct* of the latter plate; and (2) in comparing the glandular structures of *Carinina* more especially with the deeper layer of glands of *Eupolia*, and in looking upon the unicellular glands of the latter as more particularly developed in the outermost layer. These latter are then comparable to the smaller and superficial unicellular glands which are met with in *Carinina* (Pl. IV. fig. 1). Similar considerations concerning the homology of the different portions of the integument can be applied, as we shall see in the sequel, to the Schizonemertea, their integument in so many points resembling that of *Eupolia*, and being thus also linked to that of *Carinina* by intermediate forms, such as *Carinoma*.

Amongst the Hoplonemertea it is most difficult to obtain specimens in which the integument is in a fair state of preservation. Even in the specimens that have been treated with special care, it is a rare occurrence to find a portion of the integument in which its different layers can be clearly made out.

From what I have noticed in the Challenger specimens, there is a certain amount of uniformity which must first be noticed and compared with what obtains in Palæonemertea and Schizonemertea. Sharply distinct from the basement-membrane, which, after removal of the integument, would even show a more or less honeycombed surface, are the deeper cell-layers of the integument, the rounded bases of these cells fitting into the honeycomb-like pits in the basement-membrane just alluded to (Pl. X. fig. 2). These cell-layers, with very distinct nuclei, are in thin sections many rows thick. The nuclei are, however, never so close together as they are in the subsequent layer, which is generally situated about halfway between the basement-membrane and the ciliated surface (Pl. X. fig. 1). On teasing out the elements of this layer, we find long spindle-shaped cells, considerably thinning out at the ends, and only bulging at the spot where the deeply stained nucleus is situated. These nuclei, again arranged in several rows even in the thinnest transverse sections, are there disposed so as to fit close between each other, the thin ends of the cells being directed one towards the outer surface and the other towards the deeper layers before mentioned. It cannot be doubted that sense-cells, which very generally have a similar shape and position, are among these (*cf.* Dewoletzky, II). Towards the outer surface, the remaining stratum of the integument has the peculiar radially streaked appearance already described for the Palæonemertea; nuclei being rarer in this layer than in the two foregoing. Finally, the cilia are implanted upon the outer margin of this region, and teased preparations reveal the presence of special cells with a nucleus of a very much paler hue, and very faintly coloured. Only in a few preparations have the cilia been well preserved; a cuticula upon which they are implanted, as elsewhere (XIV) described in embryonic stages, was also only noticed in certain favourable sections.

These are the principal features marking the integumentary system of the Hoplonemertea. A few further details, however, may still be added. The deepest layer (Pl. X. fig. 2) contains fibrous nerve elements, not distinctly indicated in the figure. The absolute thickness of the layers, above described as integument, does not vary very much in smaller and larger-sized individuals. Also, in the tip of the tail, where growth is continually going on, and where the newly formed parts are thus, in the first instance, found, the integument is very much in advance of the underlying tissues in obtaining its definite size. For example, in *Drepanophorus lankesteri* I find the cellular integumentary layer (the basement membrane not included) to be on the thickest part of the body, 0·15 mm. (*i.e.*, one-twentieth the horizontal diameter in this region), and close to the tail end 0·1 mm. (*i.e.*, one-tenth the horizontal diameter in this region). In the largest specimens of *Amphiporus moseleyi*, which have more than twice the length and more than two and a half times the transverse diameter of *Drepanophorus lankesteri*, I find the integument to measure 0·12 to 0·15 mm.

Both in specimens of *Amphiporus moseleyi* and in one of *Amphiporus marioni*, as well as in one of *Drepanophorus*, it is easy to demonstrate glands in the integument by the evident presence of the secretion, partly extruding towards the exterior, partly still enclosed between the deeper layers (Pl. X. fig. 2). These glands are, however, neither so massive, nor do they form such a conspicuous layer as in *Carinina*, above described. Whether they may be regarded as unicellular, and as comparable to the superficial ones already mentioned in the integument of *Eupolia*, and also present in the Schizonemertea, or whether they are more directly homologous to the deeper glands of that division, is for the present difficult to decide by means of the preserved material in the Challenger collection. Histological investigation of fresh specimens will be necessary to clear up this point. *Drepanophorus serraticollis* would certainly tend to a direct comparison with the flask glands of *Cerebratulus*, &c. In a general way, however, the Hoplonemertean integument offers more analogy to the more primitive arrangement than to the higher differentiation of the layers in *Eupolia* and the Schizonemertea.

One further detail deserving mention is the presence of a granular deposit (pigment?) in the lower cell-strata of the integument of the last mentioned specimen of *Drepanophorus*. This deposit is different from the one hereafter to be mentioned in the tissues of *Amphiporus marioni*. A deposit comparable to the latter was absent in the specimen of *Drepanophorus* here alluded to. The granules have more resemblance to the pigment granules of *Eupolia delineata*, described above, and may probably be looked upon as such.

While we see that the Hoplonemertean integument is directly connected—at least in general outlines—with that of the Palæonemertean genera *Carinina* and its allies, the Schizonemertea are linked to the primitive stock by the intervention of *Eupolia* and *Carinoma*.

Certain Schizonemertea (*e.g.*, *Cerebratulus corrugatus*) in some portions of the integument reveal a complete uniformity with what we have described for *Eupolia*; a stratified basement layer separating the outer longitudinal muscle-bundles of the body-wall from the layer of vesicular tissue sustaining the deeper skin glands, these glands communicating by tortuous tubes with the exterior, and being separated from the outermost cell-layers with unicellular glands by a special secondary and continuous, though thin basement layer (Pl. XIII. fig. 6). Below the latter, longitudinal and circular fibres proper to the integument are also present, corresponding, even in their more massive development, to those of *Carinoma*.

There appears to me to be no doubt that this same arrangement holds good for the great majority of *Linei* and *Cerebratuli*, and the only reason why the separation of the parts is often less marked is the stronger development of the outer longitudinal muscles of the body-wall, concordant with the disappearance of the connective tissue separating the integument and body musculature, and also the fusion to a smaller or larger extent of the longitudinal muscle-fibres proper to the integument with those of the body-wall. From this it inevitably results that the line of separation between the body-wall and the integument seems to be formed by the external, secondary basement membrane, the deeper glands having the appearance of being imbedded within the longitudinal muscles of the body (Pl. XI. figs. 10, 11; Pl. XII. figs. 2 and 10). That this is a secondary arrangement, and that the real and original line of separation was another one, has been demonstrated in the foregoing pages.

It is not necessary, after the detailed description of *Eupolia* given above, once more fully to discuss the same details for those Schizonemertea that wholly correspond to the same type of integument. In those species in which the more developed longitudinal muscular layer more or less effaces the boundary line between integument and muscles (*Cerebratulus macroren*, *Cerebratulus medullatus*, &c.), the characteristic and sometimes massive layer of vacuolated cells surrounding the deeper glands is considerably reduced. The other constituent parts have retained their original character, with the exception of the thin muscular strata of the integument, which are no longer separately recognisable (Pl. XII. fig. 10).

The integument is generally very completely preserved in the cephalic fissures; it may here be noted that there, too, the deeper gland-structures of the integument may be noticed, although they are much more sparingly set. In a few cases it would appear as if they are wholly absent, and as if only the outer integumentary cell-layer is preserved in the cephalic fissures; others, again (Pl. XIV. fig. 11), offer special differentiations in the region of the cephalic fissures of the glands, which may there be united in paired accumulations. I must also mention a somewhat aberrant type of integument, as we find it represented in a *Cerebratulus* sp. inc. (*medullatus?*), from Kerguelen Island. The integumentary layers offer more general resemblance to what obtains in the more primitive Palæonemertea (*Carinina*, *Cephalothrix*, &c.) than to *Eupolia*. Eventually it might be said to retain a more primitive embryonic condition. I have at least described a developmental phase of the integument very similar to what I am now about to describe for adult forms, as occurring in the ontogeny of *Lineus obscurus* (XIV). The integument in question may, however, also be looked upon in another light, *i.e.*, as in no way more primitive, but rather as a special differentiation of the normal type of the Schizonemertean integument, the result being an apparent simplification. This simplification (Pl. X. fig. 7) 'consists in the absence of the deeper layer of gland-cells below the superficial secondary basement membrane *b*. The whole integument of this species would thus only seem to correspond to the very outermost layer (the layer of the unicellular flask glands) of the other Schizonemertea. I have, indeed, the conviction, that far from being more primitive, this condition may be linked with what obtains in other Schizonemertea and in *Eupolia* by such transitional forms as *Cerebratulus medullatus*, &c. (Pl. XII. figs. 10 and 2; Pl. XI. figs. 10, 11). These species have evidently well-developed glands belonging to the deeper layer; and whilst the glands are on all sides surrounded by the longitudinal muscles, they at the same time penetrate more deeply into this layer, even at a few points touching the nervous stratum, which is superposed upon the layer of circular muscular fibres (Pl. XII. fig. 10). The special character of the integument of *Cerebratulus* sp. inc. (*medullatus*?), and the deceptive reminiscences it evokes of the more primitive stages of the integument may well be said to be due to the strong secondary basement membrane. Thus in this species the layer of the deeper glands seems to have altogether disappeared.

Before passing to another paragraph, I cannot refrain from pointing out the many points of resemblance that may be noticed between the integument of the Polyclada, now so well known, thanks to A. Lang's beautiful monograph, and of certain Nemertea, viz., those in which the integument is secondarily simplified as in those last discussed. Our external layer of unicellular glands is evidently comparable to what Lang and Gräff call the "Schleimstäbchenzellen" or "pseudorhabdites," and these in their turn are compared by Lang, on very plausible grounds, with the "Rhabditenzellen," in which the peculiar rod-like enclosures of the integument are found. The highly refractive, uniform contents of what I have called the unicellular glands, their general shape and properties, wholly coincide in their semi-viscous nature with what are described by Lang as the "Schleimkörper," and looked upon by him as merging into true glandular structures.

The Nemertean layer of deep glands is also found in the Polyclada, below the (also secondary?) basement membrane. So is the layer of nuclei regarded by Lang as belonging to a continuous stroma, by which both sense-cells and gland-cells are sustained and which was recognised by me in all the subdivisions of Nemertea. The figure given by Lang (XVIII; Pl. XI. fig. 11) would fit very well for different genera of Nemertea; only in Nemertea the rod-like viscous bodies are not subdivided into superposed blocks. Moreover, the tactile and sensory cells in the integument, as Lang describes and figures them, more especially for the tentacular integument, offer without doubt a close analogy to that outermost layer of the Nemertean integument, with its triangular cells (tip downwards), which is also found in the vast majority of species where the skin is uninjured, which is uniformly distributed over the body, and which, if indeed sensory, as appears to me most probable, would go a long way to explain the high degree of sensibility of every portion of the Nemertean body-wall.

MUSCULAR SYSTEM AND CONNECTIVE TISSUE (GELATINOUS TISSUE, BASEMENT MEMBRANE, &c.).

In describing in the foregoing paragraphs the integument and its varied constituents, glands, sense-cells, ciliated cells, &c., the tacit assumption has been made that the structures there described might be looked upon as so many derivatives of the epiblast. Although reliable embryological data are as yet very scanty, my own experience on this head (**XIV**, **XV**) appeared to me to afford justification for this assumption. However, I agree that the question, whether the thin layers of longitudinal or circular fibres, that, more especially in *Eupolia* and *Cerebratulus corrugatus* (Pl. VII. figs. 5, 9; Pl. XIII. fig. 6), form so intrinsic and conspicuous a part of the integument, are also epiblastic derivatives, or whether they are due to mesoblastic elements, is open to dispute, and cannot be solved for the present on any other than the *a priori* arguments just alluded to. Hence, if I look upon the tissues that are treated of in the present section as essentially mesoblastic structures, I wish it to be well understood that this distinction may after all not be a final one.

I have purposely omitted discussing the basement membrane of the integument under the head of the integument, because it appears to find its more natural place amongst what we are now going to describe: the tissues between the outer cell layers and the intestinal epithelium, *i.e.*, the muscular body-wall and the connective tissue (better, gelatinous tissue, "Füll-Gewebe"). The latter is not only present in the space between the body-wall and the intestine (so far as it is not encroached upon by the generative, blood-vascular, or nephridial systems), but also between the individual muscle-bundles, when these are not very closely applied against each other, and outside of these, between the muscles and the integument, as the so-called basement membrane above mentioned.

The question as to the exact nature of this tissue is, in my opinion, a very important one. It represents the tissue which in Cœlenterata fills the space between epiblast and hypoblast, the "jelly" of Medusæ and Ctenophora, with its multifarious inclusions of muscular, fibrous, and eventually nervous nature. This jelly is the more important since its distribution, in the way above defined furnishes a strong argument for the view, also held by me, that the Nemertea are devoid of a body-cavity comparable to that of Arthropods, Annelids, and of Vertebrates. The only body-cavity proper to the Nemertea is the modified segmentation cavity, the archicœlome, as I have elsewhere proposed to call it (**XIII**, **XIV**). Of the cavities of the generative sacs and of the nephridia mention will be made in the respective paragraphs.

It will be well to consider this connective tissue more closely before we pass to the description of the muscular layers of the body-wall. From the foregoing it may already be inferred that there is a direct continuity between the different parts of this gelatinous tissue, be it situated close to the intestinal epithelium or to the integument, and that this continuity is more or less completely interrupted by the muscular layers. We may thus conclude that it will be most prominent in those species that have the muscular body-wall reduced to a minimum, whereas it will be hardly visible in species that have a very strongly and massively developed musculature. This is indeed the case, *Pelagonemertes* offering a very striking example of the first category, *Carinina* of the second.

Although the latter species is by far the most primitive, I would hesitate very much in at the same time regarding the relation of the gelatinous tissue to the body-musculature of this deep-sea form as typically representing the original arrangement. Both species mentioned represent an extreme; the normal starting point may be more easily derived from what we find in *Eupolia* and in most Hoplonomertea. It then becomes obvious that our gelatinous tissue, though uniform and continuous, still appears in three principal modifications, which, however, are often connected by transitional phases having the characteristic features of more than one of these modifications.

The first of these modifications is found between the muscles and the integument, the second in the midst of the muscular bundles, the third between the muscular investment and the internal organs.

The first modification just alluded to appears in *Carinina* (as also in *Carinella* and other Palæonomertea not collected by the Challenger) as a wholly homogeneous basement layer, on which the deeper cell layers of the integument are implanted, partially honeycombing it in the way above noticed. It is strongly stained by picrocarmine, and in *Carinella* traversed along circular and longitudinal tracts by nervous tissue. In *Carinina* the corresponding tracts are still situated in the deeper layers of the integument itself. Nuclei are very rare. What is a distinct basement layer in the more primitive Palæonemertea just named, retains this character with but little change in the Hoplonemertea. One change which is revealed at first sight is a distinct though exceedingly fine stratification, that becomes apparent in the basement membrane of nearly all Hoplonemertea. Along with this we very often find included in the Hoplonemertean basement layer distinct and sometimes numerous nuclei. The other inclusions in it, as they are figured on Pl. X. fig. 1, *B*, appear to be parasitic unicellular organisms infesting this particular specimen (see p. 49). Besides the exceedingly fine stratification which is parallel to the surface of the body, and which is often thrown into wavy folds, there are numerous radial tracts that would seem to transverse this basement layer, but are often only due to slight differences in texture and coloration, or to hardly susceptible folding or contraction (Pl. VIII. fig. 13). Where actual radiating fibres can be demonstrated, they sometimes are found to be extremely thin nerve-stems connecting the cellular integument with the central nervous system, whereas in other cases their spiral coiling and their affinity for staining solutions permits us to define them as contractile or elastic fibrils. It is, however, not to these radial fibrils that the extreme pliability and continual change in thickness of the basement membrane of the Hoplonemertea can be ascribed. This phenomenon must be an inherent quality of the tissue itself, and may be studied in every transverse section, where the outer boundary line of the basement membrane is only very rarely parallel to the inner one. Generally it is strongly undulated, in accordance with the folds and wrinkles into which the integument may be thrown, not only during life, but also when the animal is preserved in spirit. The consequence of this undulation is, that in several places the integument much more closely approaches the muscular body-wall than in others, where it is kept very widely apart, the basement membrane being in the first case compressed; in the second, extended to its utmost limit.

Together with this extension and contraction, the fine parallel stratification changes its aspect, becoming more coarse, and sometimes so coarse that it might be difficult not to look upon the basement layer as composed of fibres. A confusion with subjacent muscular layers would in some cases be pardonable. A comparison of longitudinal and transverse sections reveals, however, the fact that it is indeed no fibrillar, but a stratified condition. Another change accompanying these phenomena of extreme plasticity is the change in colour, the staining appearing far more intense when the strata are in the contracted than when they are in the expanded condition. The nuclei remain visible in both cases. How the change of shape and the successive expansions and contractions are actually brought about in this homogeneous though laminated tissue, which has more the appearance of being intercellular ground substance than anything else, must here remain an open question, which we shall again meet when treating of the contractions of the muscular body-wall.

In Pl. VIII. fig. 13, and Pl. X. figs. 1, 2, different aspects of the Hoplonemertean basement membrane are given. I will now pass to those of the Palæonemertean genus, *Eupolia*, that in so many respects leads over to the Schizonemertea. In certain specimens of this genus an arrangement, more or less corresponding to what has just been described, was in a few cases met with, the basement membrane being of about the same thickness all round, finely striated, with imbedded nuclei, and sharply separated from the integument (Pl. VII. figs. 3, 9, *Bct*).

In other cases the membrane separating the muscles and the integument is much more folded, more irregularly striated, and less characterised as a separate band of distinct tissue (Pl. VII. figs. 2, 5, *Bct;* Pl. X. fig. 6, *B*). Especially in these latter cases it is quite clear that this band of tissue, to which the name of basement *membrane* can only be applied with particular restrictions, imperceptibly passes into the connective tissue found between the longitudinal muscular bundles of the outer layer, where it is moulded between these bundles, and also carries in the nephridial regions the terminal deferent portions of the nephridial ducts (Pl. VII. fig. 5, *Nep*). The originally cellular nature of this connective tissue is retained in the head and in the anterior portion of the trunk, where the outer longitudinal layer of muscles is not less thick, but certainly contains a very much smaller number of fibres, because of the permanence of the intermuscular cellular stroma just alluded to. A comparison of figs. 2 and 3, Pl. VII., the one taken through an anterior, the other through a more posterior region of the trunk of a *Eupolia*, will elucidate this, as will also the comparison of fig. 5, Pl. VII., with the more enlarged fig. 6 of Pl. X. (taken from the same specimen), which represents a section through the region marked *Bct* in the former figure situated further forwards, and thus decidedly cellular as far as concerns the intermuscular tissue. One important fact is clearly indicated in this latter figure, viz., that the cells situated between the muscle bundles of the outer longitudinal layer (*γ.rl*), although their general aspect, vacuolation and arrangement very much resemble that of the similarly vacuolated cells of the deepest layers of the integument (*Jdrl*), may nevertheless be immediately distinguished from these by their much larger nucleus. The same fact follows quite as unmistakably, though somewhat less clearly, from Pl. VII. fig. 2. It gives some support to the hypothesis, that the whole of the deeper cell-rows of the integument, vacuolated or otherwise, being substantially different from the subjacent mesoblast cells, may be looked upon as epiblastic. However, this question, which pertains more to an ontogenetic than to an anatomical investigation, may safely be left out of further consideration. This basement tissue of *Eupolia*, much less regularly arranged than in Hoplonemertea and in the Carinellidæ, is thus still directly homologous with that of the latter.

A secondary external homogeneous basement layer is found immediately below the outer stratum of unicellular glands of the integument ; in the paragraph devoted to the integument the comparison with *Carinina*, *Carinella* and *Carinoma* has been already instituted, and it was at the same time shown in what way these different arrangements may be identified with one another.

In the anterior portion of the body the stratified basement layer *Bct* (Pl. VII.) fuses with the sparse intercellular tissue that is present round the vacuolated cells, and appears to be a direct continuation of it. In the posterior portion, however, where the muscular bundles are more strongly developed, this stratified tissue appears more limited to the region between the muscles and the integument, principally because here the character of the intermuscular tissue is also changed and becomes more homogeneous, although it is here and there traversed by radial fibres, is also provided with nuclei, and contains numerous nerve-tracts. The general aspect, and the effect of the staining reagents, show this intermuscular tissue to be identical with the homogeneous, more or less gelatinous tissue, that is observed between the outer longitudinal bundles of *Carinina* (Pl. III. fig. 6). The cells, of which traces are found around the nuclei contained in this homogeneous intercellular substance, show a very delicate granulation, and it is often very difficult to decide whether a given one belongs to the nervous network, or whether it is a more indifferent cell, appertaining to the gelatinous ground-substance. In the former case the connection with the nerve-plexus is of great advantage in the decision, and but for this such a decision would often be wholly impossible. The fibres generally offer less difficulty, the delicate nervous fibres being sufficiently distinct from the elastic or contractile fibrils. The intermuscular homogeneous tissue of *Eupolia*, and its inclusions in the region somewhat behind the head, are figured in Pl. VII. figs. 4, 5. In its deepest part, immediately surrounding the circular muscular layer, we find the nervous stratum, that will be more fully discussed further on. We must mention this, because in certain of the Schizonemertea (Pl. XII. fig. 10), to whose basement membrane and intermuscular tissue we have now to direct our attention, glandular structures belonging to the integument reach as far down as this layer; a factor which we have to keep well in view when discussing the tissues to which this paragraph is devoted. This is all the more necessary, because in that case the other deeper cellular components of the integument are reduced in number, whereas the outer longitudinal muscular layer having become more compact and dense, the intervening region between these two, the region *Bct* of Pl. VII., has vanished from view. The secondary basement membrane (*B*) is then the sole representative of such a structure, and might easily, but as I hope I have demonstrated, injudiciously, be looked upon as homologous with the basement membrane of *Carinina, Carinella*, &c. (*cf.* Pl. XI.).

An arrangement of the basement membrane, wholly comparable to what we have described in *Eupolia*, is found in such Schizonemertea as *Cerebratulus corrugatus* (Pl. XIII. fig. 6, *B,b*). In most of the others the strongly developed and massive outer longitudinal muscular coat so much encroaches upon the deeper layers of the integument in the way just noticed, that it is no longer possible clearly to distinguish between the two integumentary muscular strata (*Ilcm*) and the subjacent one constituting the body-wall (γ). The extreme representatives of this development are figured on Pl. X. fig. 7, and Pl. XII. fig. 10.

We now resume our examination of the gelatinous tissue, which we have as yet only examined as subintegumentary basement membrane (*Carinina* and Hoplonemertea), or also as intermuscular substance (*Eupolia* and Schizonemertea) in its further participation in the muscular investment. In the circular and inner longitudinal layers gelatinous intermuscular tissue is unmistakably present, and its presence is revealed both by the nuclei and by its peculiar homogeneous appearance, but at the same time, owing to the far greater compactness of these last named muscular layers, when compared with the outer longitudinal one of *Eupolia*, the position of the connective jelly is much more subordinate, and its presence less easily demonstrable. Still it may be observed in the larger species that, besides the distinctly granular cells included in it, striation in nearly every direction forms a prominent feature of this intermuscular substance.

Inside the innermost muscular coat the gelatinous tissue appears in the third modification which we have established for it. This modification is in many respects the most important, and at the same time most liable to a considerable amount of variation according to the species we happen to examine. It has been already noticed that of all Nemertea *Pelagonemertes* shows it in its fullest development, whereas the eminently muscular *Carinina* is only very sparsely provided with it. It will thus be safest first of all to examine it in *Pelagonemertes*, and to indicate by what features the other genera differ and gradually lead to grades of development as far down as *Carinina*.

The most striking feature in examining any section of *Pelagonemertes*, either with low or high powers, with a special view to the gelatinous tissue inside the muscular body-wall, is the homogeneity of this tissue, the comparative scarceness of nuclei, and the uniform imbibition of the staining reagent, by which it has obtained a delicate rose colour. A comparison with the medusoid jelly, or, more distantly, with the intercellular substance of cartilage, is here inevitable.

This general feature being established, the secondary characteristics are—(1) the imbedded nuclei of this jelly; (2) the fibres forming part of its substance, other fibres traversing it in apparently tubiform channels; (3) differences in the coloration of the jelly in different regions, and lastly, a fibrillation of the utmost tenuity, only visible by the aid of very high powers, which appears in different regions of the apparently homogeneous jelly, other and large portions, however, retaining the homogeneous aspect even with these high powers, though then not appearing wholly limpid but cloudy, perhaps an indication of a yet finer fibrillation escaping the analysing power of our objectives when studied, not in the fresh state, but in Canada balsam.

The different coloration of the jelly in different regions is partly arbitrary, *i.e.*, darker-coloured patches are irregularly scattered throughout the general lighter hue. At certain places the darker staining is, however, constant, viz., contiguous to those regions where the jelly is interrupted. Thus the channels above alluded to, in which nerve-fibres and others take their course through the jelly, are marked by a double boundary line of darker colour (Pl. VIII. fig. 6, *n″*), corresponding to the tract along which the continuity of the jelly is interrupted for the passage of these fibres. These nervous tracts being exceedingly numerous, the transversely or obliquely cut ends of similar distinctly red tubes are discovered in every section (Pl. VIII. fig. 3). Moreover, all round the two principal nerve-stems (figs. 6, 8), and bounding the cavity of the proboscidian sheath (Pl. VIII. fig. 12, *B*), the blood spaces (fig. 8, *bl*), and the cavities in which the generative products are lodged (fig. 8), the same continuous dark red tint, which that portion of the jelly has acquired by the picrocarmine, is observed.

A peculiarity which I have further to notice in the sections, is the different hue that has been acquired by two superposed layers of the basement membrane of *Pelagonemertes* (Pl. VIII. fig. 13, *B*, *B'*); the outer one being darker than the inner. I have no explanation to offer of this phenomenon, nor of the fact shown by the same figure (Pl. VIII. fig. 13) that the same phenomenon is repeated just below the basement membrane, the jelly between the bundles of longitudinal muscles being much darker than that which is found inside. The latter, into which the former gradually merges, is not specially indicated in fig. 13. Mention ought here to be made of what is marked *dr* in that figure, and what appears to be in several cases (Pl. VIII. fig. 5) a central cavity enclosed by peculiar cells, of which the nuclei are specially distinct. I must leave it undecided whether these structures, radially directed towards the surface of the body, are the same as the masses *dr* (Pl. VIII. fig. 4), which I see in a glycerine preparation of the integument made by Professor Moseley on board the Challenger from the fresh animals, and also whether these structures might be looked upon as glandular, and comparable to similar gland-masses in the jelly of *Amphiporus moseleyi* (Pl. XV. figs. 11, 12).

That the course of the fibrils traversing the jelly is in no way strictly limited to certain directions, but that we find them now parallel to the proboscidian sheath, now to the intestinal wall, now convergingly directed against the generative ducts, is sufficiently demonstrated in Pl. VIII. figs. 3, 8. A very large number are, however, radially directed towards the surface, and though it was not observed in one section, it might perhaps be possible to find dorso-ventral fibres uniting both surfaces. That the nerve-stems, springing from the lateral cords *N* (Pl. VIII. fig. 3), are indeed encased in a tubular space bounded by darker stained gelatinous substance, is best seen in fig. 6 of the same plate, as well as the fact that in the immediate neighbourhood cells and fibres (*f*) form part of that substance.

In the other Hoplonemertea this continuous jelly, though much less prominent, has very much the same character as in *Carinella*, with the exception that no special tubiform tracts for the passage of nerves, &c., are as distinct as they are in *Pelagonemertes*. The passage of radial fibrous tracts through the gelatinous tissue is, however, everywhere demonstrable (Pl. X. figs. 1, 2), as is also the origin of these fibres out of cells (Pl. X. fig. 2), and the continuity of the gelatinous stroma with that contained between the muscular bundles of the body-wall. The Challenger Nemertea not offering anything very special in this respect, I will postpone a more circumstantial discussion of this tissue for the monograph which I am preparing for the Naples series.

Similarly I may rapidly call to mind that, in the Schizonemertea, where this gelatinous substance is best observed in the posterior region of the body, and better in large specimens than in small ones (Pl. XV. figs. 7, 10), it offers the same characters. Anteriorly, where the circumœsophageal blood-space is present, it does not play any conspicuous part; posteriorly, however, it carries not only the tubular continuations of this space (the three longitudinal blood-vessels) but also the other internal organs, to all of which it is closely applied.

Here, again, its generally homogeneous character, with the addition of the same cellular and fibrous inclusions (intermediate stages between the two being similarly represented) as were noticed above, gives it an aspect similar to the corresponding tissue in the other groups of Nemertea.

It cannot be denied, and has been already noticed above, that from a morphological point of view there are certain strong points of resemblance between the gelatinous tissue of the Nemertea and the jelly of the Medusæ. I was very desirous to know whether this would also apply to the chemical constitution, and owing to Professor Krukenberg's kind aid I am now able to make definite statements on this head. Having sent him a small quantity of the Nemertean jelly, he kindly examined it and writes as follows:—

"In accordance with your desire I have attempted, as far as it is possible, chemically to solve the question, whether the jelly of the Nemertea is more closely allied to that of the Medusæ or to the collagenous substances, such as I have with certainty demonstrated in *Sipunculus nudus* (Vergl. physiol. Studien., i. 1882). As collagenous tissue is digested by trypsine, *only* in case of its having before been treated with acids or been boiled with water (Ewald and Kühne), I tested the reaction of the Nemertean jelly towards this ferment. It proved to be very easily digested by trypsine, and would thus have to be regarded as a true proteid substance. Wholly in accordance with this result is the intense red colour which the tissue acquires when boiled with Millon's reagent; whereas, on the contrary, tissues that contain more collagen are only faintly stained, and pure collagen is not stained at all by Millon's reagent. Moreover, the Nemertean jelly is not acted upon as are the collagens ('leimgebendes Gewebe') by boiling water, nor does it furnish, when treated with diluted acids and soda, such reducing solutions as are the so-called mucins (Hyalogene, mihi). The Medusa-jelly consists of true proteid bodies.[1] A similar substance is the vitreous body of the eye of vertebrates, and I am thus fully prepared, after the experimental results obtained, to agree with you in regarding the Nemertean jelly as an analogous product to the jelly of the Medusæ, and similarly of an albuminoid nature."

We now pass to a discussion of the muscular layers. We will first discuss the general distribution of muscular tissue, and reserve histological remarks for the conclusion.

In discussing the muscular layers of the body-wall of the Nemertea, considerable confusion still obtains in the writings of most of the older authors, and I must confess that it took me a long time to see my way to a safe basis of comparison of the layers, that may sometimes be only one, sometimes no less than five in number, three or two being also very common occurrences. An outline of the homologies of the muscular layers was given by myself in the article Nemertea in the recent edition of the Encyclopædia Britannica, and in the views there propounded I have no changes to make, only certain further additions have been rendered possible by the aid of the Challenger material.

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[1] Krukenberg, Vergl. physiol. Studien., ii., 1 Abth., pp. 23–34.

In all Nemertea, to whatever order or genus they may belong, there is one muscular layer that is always present. This layer may, indeed, be looked upon as identical throughout the whole series, and consists of longitudinal muscle-fibres. It is the longitudinal layer of *Cephalothrix*, in which genus definite or conspicuous circular layers sometimes appear to be absent (Pl. XI.); it is the only longitudinal layer of the Carinellidæ—the longitudinal layer of muscle-fibres in the integument of *Carinoma* not being here taken into account, as indeed belonging to another system—and it is the so-called inner longitudinal layer of *Polia*, *Valencinia*, and of all Schizonemertea. In Pl. XI. this layer has uniformly been lettered α. I hold it to be the most primitive of all the Nemertean muscular layers, both on account of its constant presence and on account of the fact that in the posterior region of the body, where growth in length of the animal takes place, it often appears before the other layers that are present in addition to it in the anterior region of the body.

The layer second in importance to it (morphologically speaking) is a layer of circular fibres marked β, of very varying thickness, and which in the Carinellidæ and the Hoplonemertea is immediately subjacent to the basement membrane, and external to the layer α. The very outermost fibres of this circular layer often take a different course, making an angle of about 45° with the longitudinal body axis, instead of being perpendicular to it. This, then, being the case in two directions, a decussation of this exterior portion of the layer, especially in Hoplonemertea and Carinellidæ, is often noticed.

Outside of the circular layer β there is in the Schizonemertea and in *Polia* and *Valencinia* the outer longitudinal layer γ, sometimes exceeding in thickness the two layers just noticed, and offering very varying conditions as to the compactness of its bundles. In most cases it remains entirely distinct from the two thin epiblastic muscular layers (see pp. 57 and 60) that make their first appearance in *Carinoma*, and are very generally present in *Polia*, *Valencinia*, and the Schizonemertea (Pl. VII. figs. 5, 9, *cf*; Pl. XIII. fig. 6, *Ilcm*). In some of the latter, however, a fusion occurs between the outer bundles of the longitudinal muscular layer γ, and those that are decidedly of integumentary origin and significance, as was already noticed in discussing the integument. It needs no explanation that these latter species offer more difficulties in rightly interpreting the relations between muscular system and integument than many others (Pl. X. fig. 7; Pl. XII. fig. 10).

The difference in compactness just alluded to is often dependent upon the degree of development of the deep glandular layers of the integument. Sometimes these glands penetrate the whole depth of the muscular layer, reaching as far down as the nervous stratum (Pl. XII. figs. 2, 10); sometimes the muscles are kept further apart by the gelatinous ground substance, as was more fully discussed in a preceding paragraph. *Eupolia* may on the whole be cited as an example in which the degree of compactness of this muscular layer remains at the lowest level (Pl. VII. figs. 2, 5), in *Cerebratulus corrugatus* I found it very compact, and composed of very delicate fibres (Pl. XIII. fig. 6).

Another additional muscular layer, which is not found in all but only in certain Nemertea, is marked δ in the figures of Pl. XI. It is an inner circular layer, and in the more primitive types (*Carinina*, *Carinella*, and *Carinoma*) it may even become exceedingly massive. It is directly applied against the longitudinal muscular layer α; it forms at the same time the dorsal wall of the proboscidian sheath, the exceedingly thin ventral wall of which is in these species formed by fibres of the same inner circular layer that branch off, and are directed inwards between the space for the proboscis and the œsophagus or intestine, thus creating a floor to that proboscidian space. The inner circular layer is continued ventrally, and embraces the other internal organs as well. In *Carinoma*, where the layer has such a considerable thickness in the proboscidian and œsophageal region, and where it has disappeared in the posterior region of the body, leaving only the longitudinal and outer circular layers, the conclusion is of course tempting that the special development of this layer is in a certain functional connection both with proboscis and œsophagus. And if we then find that in the Schizonemertea this layer is absent, but that, on the other hand, there is a circular muscular coat to the proboscidian sheath and that this sheath has been raised to greater independence, and remains dorsally connected with the rest of the muscular body-wall in exactly the way it would be if it were the modified remnant of a restricted portion of the inner circular layer, we are led to the further hypothesis that these two may indeed be homologous. Thus all the transverse sections of the dorsal body-wall of Schizonemertea on Pl. XI., were they to be completed by adding the circular muscular layer of the proboscis-sheath immediately applied against them in the median line, would very strongly resemble the figures given of *Carinoma* and *Carinina*.

I will not at present venture to decide whether any of the muscular layers of the œsophagus, noticed both in *Eupolia* and *Cerebratulus* (Pl. VI. fig. 9, *oe.m*; Pl. XIII. fig 6, *mto*), may also be looked upon as derivatives of this inner circular layer, but will only add that in Hoplonemertea such a musculature is hardly developed; whereas, on the contrary, the circular muscles of the proboscidian sheath have attained a very high importance, and are even more independent of the dorsal muscular body-wall than they are in Schizonemertea (Pl. IX. figs. 1–9; Pl. X. fig. 1).

Here, too, I would be tempted to hazard a comparison between the absent inner circular layer and the musculature of the proboscidian sheath.

The detailed histology of the Nemertean muscular system is hardly in its place here, and may perhaps be more fitly reserved for the monograph that will shortly appear in the Naples series.

One point must, however, be mentioned, as its definite establishment seemed important to the Hertwigs,[1] viz., the question whether the delicate longitudinal fibres composing the longitudinal muscular layers, and which in transverse sections are often arranged in rings (Pl. III. fig. 6; Pl. XIII. fig. 6), have their matrix cells between them or not. Having very often succeeded in demonstrating an evident nucleus in the midst of this ring of cut fibres, and having constantly observed a difference in the effect of the staining reagent upon this central space and upon the connective tissue surrounding the muscle bundles, I must answer this question in the affirmative.

Finally, two points deserve a short notice in this place. First, that the layer a of the longitudinal Nemertean muscles is very often separated into two, a right and a left half, by a dorso-median, sometimes also by an additional ventro-median solution of continuity. It is very marked in the primitive Palæonemertea, especially in those cases where this layer is the preponderating component part of the body musculature (*cf.* Pl. XI.); it is very rarely wholly absent in *Eupolia* and the Schizonemertea; it is less marked or even absent in the Hoplonemertea. In how far this separation may have general morphological significance, will be discussed in the chapter devoted to general considerations.

The second point on which I shall offer speculative remarks in that chapter (*cf.* p. 127) has again reference to the same muscular layer. Sometimes it was observed that in this layer darker patches of contracted fibres alternate with lighter ones in which these contractions were absent (Pl. XV. figs. 9, 10). As this phenomenon of contraction was not wholly local but stretched all round the body in rings, the question must be considered whether we have here successive waves of contraction preserved at the moment of death, or whether the phenomenon has a deeper significance, is more permanent and indeed allows of direct comparison with myotomes. The comparative rarity of the phenomenon for the present prevents us from very emphatically advocating the latter view.

How the circular layer of the Schizonemertea only stretches to the posterior brain-lobes, how the longitudinal muscles decussate in all directions in the head, how the development of the cephalic musculature is ontogenetically separated from that of the body musculature, are points already known to former investigators of the anatomy and embryology of the group. The fact of their having found ample discussion and mention in other monographs, and the Challenger material not having furnished new points of interest, will explain my silence in this Report on these and other points (such as the muscular dissepiments, the musculature of the cephalic slits, &c.) connected with the muscular system.

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[1] Die Cœlomtheorie, p. 37.

NERVOUS SYSTEM.

With respect to the nervous system, I am indebted to the Challenger collection for very valuable additional data. In former publications (IX, X) I have dwelt at length on the peculiar arrangement of nervous tissue in the Nemertea as I had found it to exist in specimens that were obtained at Naples; I am now enabled to give a more exhaustive description of this important system, and will commence by a short account of certain points in the latest investigations into the nervous apparatus of the lower forms of animal life, in order the better to explain the bearing upon questions of general morphology which the arrangements as we find them in the Nemertea may happen to have.

The general and important conclusions arrived at by Kleinenberg in his classical Memoir on Hydra, conclusions which have since found their way into handbooks and textbooks as Kleinenberg's Theory of the neuro-muscular cells, have of late years been emendated by O. and R. Hertwig. These investigators have propounded a general hypothesis on the phylogenetic development of the nervous system, which in their treatise Das Nervensystem und die Sinnesorgane der Medusen (Leipzig, 1878), is formulated (p. 170) as follows:—

"We assume that in all Metazoa the ectoderm from which the (animal) nervous system, with its motor and sensory terminal apparatus, has originated, was primitively constituted of a simple layer of homogeneous cells in the same way as may be noticed everywhere in the earliest ontogenetic stages. We further assume that these cells, or at least part of them, have at an early period entered into mutual connection by protoplasmic processes, and have thus formed a more closely connected cell-stratum. According to our hypothesis, and on the principle of division of labour between the cells thus connected, there has been gradually developed a primitive nerve system out of this connected stratum. Whilst certain of these cells secreted contractile substance, others were provided on their surface with tactile hairs, and a third set acquired very numerous connections, the simple epithelium cells of the one-layered ectoderm thus becoming gradually and more or less simultaneously differentiated into epithelial muscle-cells, sense-cells, and ganglion-cells. Their protoplasmic connections, modified into specific nerve substance, have *pari passu* become converted into a plexus of nerve fibrils. When, later on, the ectoderm became constituted of more than one layer, the ganglion-cells were the first (of all the three elements just mentioned) to separate from the surface epithelium and to acquire a deeper situation."

Balfour, in his Comparative Embryology (vol. ii. p. 333), accepts the leading features of this important hypothesis, partly substituting it for the earlier suggestion of Kleinenberg. The latter, in his latest publication,[1] revindicates his original theory against the

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[1] *Zeitschr. f. wiss. Zool.*, Bd. xliv. p. 204.

Hertwigs' objections, and maintains that these naturalists have furnished arguments in favour of his hypothesis rather than of their own interpretation (*loc. cit.*, p. 205). Kleinenberg holds that the naked nerve-cells of *Hydra*, that are in mutual and direct communication, may transmit a stimulus by contact without the intervention of a delicate network of inter-cellular protoplasmic threads forming a network. He, moreover, holds that the epithelial cells had all of them the double significance of nerve-cells and muscle-cells, *i.e.*, were true neuro-muscular cells before further division of labour set in, whereas the Hertwigs maintain that this division of labour took place between epithelial cells that were not yet physiologically so far differentiated.

A nerve plexus, which covers a very large surface, was actually demonstrated by the brothers Hertwig not only in *Actinia* and other Cœlenterata but also in the Chætognatha. Of the latter O. Hertwig says :[1]—

"By the fact of the nerve-fibres crossing and decussating in the most complex and diverse ways, there is formed a nerve plexus which spreads over the whole surface of the body, and in which the above described nerve-stems represent the single collecting tracts."

A more or less similar plexiform arrangement of nerve-tissue has since been demonstrated in nearly all the lower groups of invertebrates, Annelids[2] and Arthropods excepted. Thus in the works of Lovén, Greeff, Teuscher, Ludwig, and Carpenter the nervous system of the Echinoderms is described as offering many analogies with the type propounded as the most primitive by the Hertwigs.

Nemertea, Turbellaria, Trematodes, and Cestodes can now be very fully compared, as far as their nervous system is concerned, with Hertwig's starting point, when we consider the results obtained by myself (IX, X)—which were afterwards confirmed (II) by Dewoletzky—for Nemertea; by Lang, Graff, and Pintner for Turbellaria, Trematodes, and Cestodes.

Among aberrant forms one of the most striking examples of a thick epiblastic nerve-plexus with longitudinal collecting tracts is offered by *Balanoglossus*, as described by Spengel and more lately by Bateson. We shall have occasion again to refer to this interesting nervous system further on.

For Mollusca, remnants of a more or less plexiform arrangement were found to exist in the Amphineura by myself[3] (*Proneomenia*) and by Haller[4] (*Chiton*), and also in other groups of Mollusca by Semper,[5] Simroth,[6] and others.

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[1] Die Chætognathen, p. 34.

[2] Lately Fraipont (*Archives de Biologie*, 1884, p. 274) has demonstrated the presence of an intermuscular nervous plexus in *Polygordius*, *Protodrilus*, and *Saccocirrus*, and thus opened the possibility of also bringing the Annelids within the region of comparison so far as this point of their organisation goes. Bergh describes a nerve-plexus in the larval *Aulostoma* (*Arbeit. Zool. Zoot. Inst. Würzburg*, Bd. vii. p. 238). As to Arthropods there are facts which also point in the same direction, *e.g.*, that Hoek mentions "a continuous network of ganglia and nerves" on the inner surface of the integument in Pycnogonida (Zool. Chall. Exp., pt. x. p. 116).

[3] *Niederländ. Archiv f. Zool.*, Suppl. Band, 1881.

[4] *Zool. Anzeiger*, No. 76.

[5] *Archiv f. Mikr. Anat.*, Bd. xix., p. 124, 1877; *Arbeit. Zool. Zoot. Inst. Würzburg*, Bd. iii., 1877.

[6] *Zeitschr. f. wiss. Zool.*, Bd. xxxii. p. 304.

For Vertebrates a plexiform arrangement is known to exist in the embryonic stages of Amphibia, since the researches of Remak and Stricker, and has lately been fully commented upon by Gœtte and Baldwin Spencer.

The last writes :[1]—"There may be said to exist in the Amphibian embryo a complete superficially-placed nervous sheath, out of which not only the central nervous system but all the sense organs of both head and trunk are formed, and which gradually disappears as these reach their full development." And further on :—"Along certain lines the cells of the nervous layer proliferate, and it is by this proliferation that the rudiments of the cranial nerves are laid down" (*cf.* p. 133).

The significance of this plexiform arrangement of the embryonic Vertebrate nervous system will be discussed in the chapter devoted to General Considerations, and also the peripheral plexus of the adult *Amphioxus,* which lately has been more fully described by Rohon.[2]

Hence, since my former publications above cited, the necessity has grown more and more obvious of not looking upon the brain-lobes and the lateral nerve-stems of the Nemertea as *the* nervous system, but, though recognising their significance as more highly developed centres, to admit the presence of a most complicated and intricate network of nerve-tissue, originally—and in the more primitive species still—belonging to the integument. This network is most fully developed in the Schizonemertea. In *Carinina* its situation in the integument makes it more difficult to observe; still I succeeded in demonstrating it both here (*cf.* p. 54) and in the other Carinellidæ. In the Hoplonemertea the plexus has been replaced for the greater part by distinct nerves, of which the majority show a metameric arrangement.

We will now pass to a more detailed description of this network, thereby purposely inverting the natural order by reserving the centres for the last. This apparent discrepancy disappears, however, when we look upon the network as the most ancient nervous arrangement, in which the centres have only gradually come forward.

When once the eye has been trained by repeated observation to notice this particular nervous tissue of the Nemertea, it is comparatively easy to distinguish it from the surrounding tissue. The peculiar punctate striation, the yellowish tint of the fibrous elements, the very pale carmine hue of the nuclear ones, immediately reveal the presence of nerve-tissue in sections, longitudinal or transverse, that have been made through specimens stained with picrocarmine.

And when we take for our starting point, and as a basis for further description, one of the Schizonemertea of the Challenger, *e.g.*, *Cerebratulus corrugatus* (Pl. XIV. figs. 3, 4; Pl. XIII. fig. 6, *pl*), we observe in all transverse sections that the two lateral nerve-stems *are in continuous connection with each other* by nervous tissue that spreads out all round the circular muscular layer β, both dorsally and ventrally. Immediately outside of

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[1] Some Notes on the Early Development of Rana temporaria, *Quart. Jour Micr. Sci.*, Suppl., 1885.

[2] *Denkschr. d. k. Akad. d. Wiss. Wien* (*math.-nat. Cl.*), vol. xlv.

this nervous layer the longitudinal muscular coat γ is situated. There is, moreover, present a third longitudinal nerve-stem, also situated, as are the two lateral ones, in this plexus, but medio-dorsally in the vertical plane that passes through the animal. It is this nerve which I have in a former publication (IX) proposed to call the proboscidian-sheath nerve, but of which I will, in the chapter devoted to General Considerations, offer a modified interpretation (p. 131) and which I will henceforth call the medullary nerve.

The nerve-plexus uniting the three longitudinal nerve-stems, as a cylindrical coat of tissue between the longitudinal and the circular layers of muscles, cannot be separated or spread out flat, nor can we succeed in getting horizontal sections of it, just because of this cylindrical curvature. A portion of it may, however, be contained in the few consecutive sections passing in a horizontal plane through the medio-dorsal nerve or elsewhere, tangential to the cylindrical surface of the nerve-plexus.

From such horizontal sections figs. 2, 3, and 4 of Pl. XIII. and fig. 1 of Pl. XIV. have been taken, and where the plexus (*n. pl*) is touched right and left of the medio-dorsal nerve *m*, it has wholly the appearance of a dense network, the meshes of which are more especially due to the fact that radial bundles of contractile tissue—by which the muscular layers and the integument are held together, and which may even pass from the dorsal to the ventral body-wall of the animal—pierce the nerve-plexus. The longitudinal dorsal nerve stands out very boldly in the midst of the plexus. It is extremely important, and may be verified in any other surface section of the nerve-plexus, that from this dorsal nerve spring, both right and left, at more or less regular distances, thicker tracts of nerve-tissue (*tr. n.*), also forming part of the plexus, but being straight instead of tortuous, and having altogether the character of metamerically arranged nerve-stems that are not yet recognisable as independent structures, but that are fairly on the way to special differentiation as so many chief conducting tracts of nervous energy in the midst of the plexiform nervous tissue which binds them together.

The presence of these transverse stems may also be noticed in transverse and longitudinal sections as a local thickening of the plexus, but as the whole stem is rarely attained in one transverse section, this thickening may be followed in consecutive sections, and is found stretching from the medio-dorsal down to the lateral nerve-stems.[1] How far these transverse stems may be said to be metamerically arranged, everyone may judge for himself by consulting fig. 1 of Pl. XIV. The chief tracts are certainly symmetrical, *i.e.*, spring from the longitudinal dorsal medullary nerve at opposite points, and about the same distance may also be seen to separate each successive pair from the foregoing. Other transverse bundles, some thinner, some thicker, some more obliquely placed, &c., but all similarly forming part and portion of the plexus, are, however, visible between the

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[1] Von Kennel, who has so considerably advanced our knowledge of the Nemertea, appears to have observed, as early as 1879 (Die in Deutschland gefundenen Landplanarien, p. 39), the presence of certain of these transverse dorsal nerve-stems (commissures, v. Kenn.). He did not, however, notice or describe the nerve-plexus, nor the fact of the existence of a ventral connection, both by means of the plexus and of ventral metameric stems.

principal ones, and it is this fact that more or less obscures the metamery here alluded to (Pl. XIII. figs. 2, 4). This metamery in the nervous plexus is of the same character as the metamery that is noticed in the intestinal arrangement, in the nephridia, in the generative organs, and in the blood vascular system of the Nemertea; it may indeed be called incipient. To its significance, for the important question of the origin of segmentation, we shall have occasion to return by and by.

Amongst the forms in which I found the metamery to be very distinct, *Cerebratulus angusticeps* stands foremost (Pl. XIV. fig. 1). And I must here call attention to the fact that the transverse stems here described are not only dorsally, but also ventrally, most regular and conspicuous, uniting the longitudinal nerve-stems below the intestine by a regular series of transverse commissures in the plexus, which is the primary connecting medium. It is important to note that there is no ventro-median longitudinal stem in Nemertea opposite the dorso-median one; and not less important, that the same favourable species just named enables me to establish with certainty that the ventral transverse stems reach much further forwards than might originally be expected. The mouth alone interferes with their course; they are, however, found immediately before as well as behind it, and whilst in front of the mouth the lateral stems very soon merge into the lower brain-lobes, it is clearly seen that the transverse commissures are still recognisable, *i.e.*, *that the lower brain-lobes are united by thin ventral commissures*, separated by a very short distance, till close up to the massive ventral commissure that has been hitherto regarded as the only ventral connection between the brain-lobes. The thin commissures just described are, however, not directly connected with the fibrous core of the brain-lobes, which is, on the contrary, directly continued into the massive inferior commissure, but they seem to derive their fibres from the outer cellular coating of these lobes. They pass underneath the two vagus stems, where these spring from the lower brain-lobes, and where these are in their turn, in front of the mouth, united by transverse commissures, as was noticed above (p. 38, 45; *cf.* Pl. XIV. fig. 5).

The histological description of the plexus may be very short, and has already been touched upon in the beginning of this section. Fibrous and cellular nerve-tissue are very regularly intermixed, the direction of the fibres follows that of the tracts in which they are found, and the fibres are, on the whole, closer together than they are often found in other Platyelminthes, where the designation of the nerve-stems—before they were recognised as such—as "spongiose strands" (spongiöse Balkenstränge) was current, and not inadequate. The nerve-fibres, however, are not so closely bound together, that the bundles are not very frequently found to be pierced by radial contractile fibres, as was noticed above, and is rendered evident by comparison of Pl. XIII. figs. 3, 4, *rf.* That this intermixture is indeed a primitive character may safely be concluded, if we observe that Lang in his monograph on the Polyclada (XVIII) specially mentions similar features in the nervous arrangement of that group of Turbellaria, and also if we remember that in *Carinella* the passage of strong contractile fibres, even through the substance of the brain, was already known (IX).

Of the cellular elements enclosed in the plexus the nuclei alone are conspicuous, and it is rare to find, either in the plexus or in the medullary nerve, distinct cell outlines (multipolar or other) round these nuclei, such as they are very often found in the brain.

The nuclei characteristic of medullary nerve and plexus have exactly the same dimensions and shape as those that constitute by far the greater portion of the cellular coating, both of the brain-lobes (Pl. XIII. fig. 1; Pl. XII. figs. 1–4) and of the lateral nerve-stems. The direct continuity between the nerve-fibres of the plexus, and those forming the axis of the lateral nerve-stems, can be demonstrated in all well-preserved sections, at any rate in those species where the plexus is well developed (Pl. XII. fig. 2). Nor is the continuity with the fibres of the medullary nerve subject to any doubt (Pl. XII. figs. 3, 4).

This medullary nerve, a dorso-median thickening in the plexus, may be traced backwards down to the hindmost extremity of the body, forwards up to the brain-lobes, and even in front of these. A section of that foremost extremity of the medullary nerve can hardly be distinguished from that of an ordinary cephalic nerve, but for its median situation, and greater size and distinctness. It is here independent, *i.e.*, not enclosed in the plexus, which does not stretch further forwards than the brain-lobes, or than the layer of circular muscles. The latter is known to cease in the region of the brain. The connection of the brain-lobes with the plexus, and with the medullary nerve, is much more intimate than I was hitherto inclined to believe. Certain specimens of *Cerebratulus* collected by the Challenger (Pl. XII. figs. 7, 8; Pl. XIII. fig. 1) permit me to form a definite judgment on this question. We there see that the anterior prolongation of the medullary nerve bends downwards in the region of the dorsal commissure of the brain-lobes, and enters into connection with a nervous stratum which may, in this region, be either considered as a median portion of the brain, or as an anterior thickening of the plexus. Large ganglion-cells can be detected in it, also fibrous nerve-matter, both of them in the most intimate connection with the nerve-cells and nerve-fibres of the brain-lobes (Pl. XII. figs. 7, 8).

From this anterior thickened region of the plexus, in which a transverse core of fibres—the dorsal commissure of the brain-lobes—takes its course (Pl. XIII. fig. 1), other fibres are seen to start in the direction of the body-axis and to arrange themselves into a longitudinal tract, which is also provided with nerve-cells, and which becomes the medullary nerve (Pl. XIII. fig. 2). My former statement (IX), that the medullary or proboscidian sheath nerve emerges from the dorsal commissure (*loc. cit.*, pl. i. fig. 1), although exact, must thus be amplified in the way just described. I may add that a direct passage of fibres of the medullary nerve into those of the commissure, though sometimes noticed, is not always a constant phenomenon. Fig. 1 of Pl. XIII shows a state of things in which the fibres belonging to the plexus and medullary nerve appear to be more or less independent from those of the brain commissure that is seen to pass under it, and to have a different texture and arrangement.

Our observations on the nerve-plexus would not be complete if we did not allude to the very elaborate branches that pass out from it into the superposed muscular layers which they innervate. Some of them can even be traced as thick radial nerves piercing these muscles, and spreading out into the integument (Pl. XIII. fig. 6, *n*). Similarly the underlying muscular layers receive fine nerve-twigs out of the plexus, which are thus directed inwards as well, and first penetrate into the circular layer β. For this reason they are best seen in longitudinal sections. The peripheral nerve system of the Schizonemertea has thus—as was already fully indicated in a former publication (X)—a totally different character from that of the Hoplonemertea. The profusion of radial nerve-stems springing from the plexus, every transverse section showing a great number of them, may convince us of the high degree of elaboration to which the nerve system of this group attains, and of which the great sensitiveness and quickly reacting movements of the worms themselves are the outwardly visible tokens.

Nor may we omit to record the important fact, which was first observed in a Challenger specimen of *Cerebratulus corrugatus*, that in the region of the long slit-like mouth and œsophagus (behind the region where the very strong nerve, to which the name of vagus-nerve has been given (V, IX), leaves the inferior brain-lobes on its way to innervate the œsophagus) we can observe that from the plexus distinct nerves become detached, pierce the circular and inner longitudinal muscle layers (β and a), cross the circum-œsophageal blood-space and enter the tissue of the wall of the blood lacunæ and of the œsophagus to assist in innervating these important organs. The morphological significance of this fact will be further insisted upon later on (*cf.* pp. 134, 142). The phenomenon is figured on Pl. XIV. figs. 3, 4.

We have now traced the facts concerning the plexus and the medullary nerve. In a general way these descriptions may be said to be applicable to the plexus of *Carinina*, which, however, as was already noticed, is a less favourable object for study. It would seem as if in this species the nervous tissue, passing inwards amidst the muscles, again spreads out into a second plexiform arrangement between the muscular layers a and δ. This phenomenon, however, requires confirmation in more specimens than the two that have been available for the present investigation.

One point alone requires a few words of further elucidation before we can pass from the nerve plexus to another paragraph, viz., the question as to whether the name of proboscidian sheath-nerve, formerly given by me to what I now propose to call the medullary nerve or the Nemertean medulla, must for the future be dropped altogether. It certainly must, if we wish to retain it for the longitudinal nerve originally so called; but, curiously enough, I have now been able to make out the presence of another longitudinal nerve to which the name may very properly apply.

This nerve is furnished with fibres directly passing downwards out of the medullary nerve (Pl. XII. fig. 9; Pl. XV. fig. 1); it is situated below this, and is entirely parallel to it.

In one case of a very large specimen of *Cerebratulus* it appeared in its turn to be splitting up into two parallel nerve-stems. This proboscidian sheath-nerve more especially deserves its name because of its situation immediately above the muscular wall of the proboscidian sheath, into which it may be seen to give off fibres. It is not noticed in *Carinina, Carinella*, or the Hoplonemertea, but it is in *Carinoma, Eupolia*, and all the Schizonemertea. Its absence in the two first-named genera would appear unaccountable if we did not remember that in both of them the proboscidian sheath is of hardly any importance, being extremely thin-walled (*cf.* Pl. II. figs. 4–7). And in this case it is all the more natural that in the œsophageal region of *Carinoma* it has become specially developed, being here even thicker than the medullary nerve, and about as thick as the lateral nerve-trunks of this species (Pl. XI. fig. 6). This is another example of sudden increase of a portion of the nervous system, and at the same time of the existence of a very marked degree of supremacy to which certain apparently subordinate parts of the organism may all at once attain. This unexpected change of size of the proboscidian sheath-nerve in one species is certainly a valuable fact for a hypothesis that will in a further chapter be enunciated (p. 133), according to which the possibility of a decrease in size of the lateral nerve-trunks is supposed to have been accompanied by an increase in significance of the medullary nerve.

The fact that in this region of *Carinoma* the proboscidian sheath-nerve comes into the foreground so strongly that it might easily be mistaken for the medulla, may probably be ascribed to the massive development of the inner circular muscular layer δ, which in *Carinina, Carinella* and *Carinoma* acts at the same time as part of the wall of the proboscidian sheath. The fact was already noticed as a peculiar feature of the species by M'Intosh (XXIV), when he first described *Carinoma* (under the name of *Valencinia armandi*).

That a proboscidian sheath-nerve is wholly absent in the Hoplonemertea is still more easily accounted for. From the moment the brain and longitudinal trunks of the ancestral Hoplonemertea were no longer lodged in the midst of the muscular tissue of the body-wall, but have come to be situated within the gelatinous tissue that fills up the space inside this muscular body-wall, not only has the plexus disappeared and been replaced by the remaining metameric nerves described above, but at the same time the innervation of the proboscidian sheath has altered. This innervation is now brought about by the peripheral and metameric nerves, which, in favourable cases (*Pelagonemertes*, &c.), may be seen to send fine twigs into the muscular tissue of that wall. With this freer development of the peripheral nerve-system, the special arrangement by which the innervation of the proboscidian sheath is brought about, as long as the nerve-sheath is the source from which all peripheral nerve-fibres take their origin, has at the same time disappeared.

It is certainly all the more remarkable that in the Hoplonemertea we nevertheless find such very distinct traces of the medio-dorsal medullary nerve, notwithstanding the disappearance of the plexus. And more remarkable still that this remnant—not distinctly traceable in only one specimen of *Amphiporus*, whilst other specimens of the same species still have it, and whilst it is even very conspicuous in *Drepanophorus* and others—should occupy the same position as it does in the most primitive Palæonemertea, *i.e.*, in or even outside the basement membrane of the integument. This is another argument for directly deriving the Hoplonemertea from the Palæonemertea. *Cephalothrix* may be said to fill up part of the distance which separates *Carinina* and *Carinella* from the Hoplonemertea as far as the situation of the nerve-system is concerned (*cf.* Pl. XI. fig. 5), whereas *Eupolia* may be said to do the same with respect to the ciliated grooves on the head, and partly also to the posterior brain-lobe, its glandular investment, and the long duct leading from it to the exterior.

We must now pass on to the description of the brain-lobes and the lateral nerve-stems.

It is known that these offer the lowest degree of specialisation in the more primitive genera of Palæonemertea, *e.g.*, *Carinella*. For this genus the brain- and nerve-stems have been sufficiently described before (IX), and, in comparing this with what we find in *Carinina*, the latter genus must be recognised as representing in this respect a somewhat higher scale in the developmental series. This higher development finds its expression in the presence of a posterior brain-lobe, comparable to the same lobe of the Schizonemertea which was often designated as the *side organ*, although it is formed of nerve-substance directly merging into that of the brain. *Carinella inexpectata* has been formerly shown (VIII) to possess a ciliated passage leading into the brain-substance, without any special differentiation of that portion of the brain into which this ciliated channel penetrates. In *Carinina* such a differentiation has set in, and the brain-substance, into which a ciliated canal leads, has become a separate lobe.[1] In consequence of this we are, moreover, enabled to draw a general—though by no means a sharply defined—distinction between the portion of the brain-mass with which this accessory lobe is in contact, and

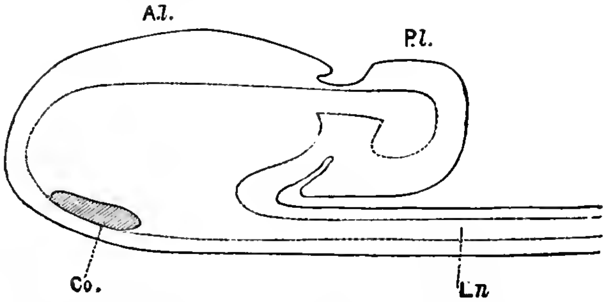

FIG. 5.—Side view of the brain of *Carinina* in outline, reconstructed from the sections. The fibrous core is indicated by a dotted line. *A.l.*, anterior lobe; *P.l.*, posterior lobe; *Co.*, ventral commissure; *Ln*, Lateral nerve-stem.

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[1] Chapuis has lately noticed posterior brain-lobes in a *Cephalothrix* (*Arch. d. Zool. Exp.*, vol. iv. p. xxi., 1886). His description is, however, very incomplete.

that which is continued into the lateral nerve-stems, *i.e.*, an incipient distinction between a pair of upper and a pair of lower lobes, respectively limited by the dorsal and ventral brain commissure; the whole forming a ring round the proboscis and its sheath. A side view of the brain of *Carinina*—reconstructed from a series of sections—is given in the accompanying woodcut, in which the very thin dorsal commissure is not indicated. A comparison with figs. 4 and 7 of Pl. V. will at once show the relation of this stage of differentiation to that to which *Eupolia* has attained. In the Schizonemertea the separation between upper and posterior lobes is more marked still than in *Eupolia* (Pl. XIV. fig. 6); in the Hoplonemertea they are definitely separated, and only connected by one or more nerve-strands (Pl. IX. fig. 10), their situation being then sometimes behind, and even sometimes before the rest of the brain.

The ciliated canal penetrating into the posterior lobe of *Carinina* is simple (not divided in two as in certain Hoplonemertea), and provided with a high, ciliated epithelium of its own. It is figured in figs. 1 to 3 of Pl. VI. Certain glandular cells, *gl. br*, are seen in this same figure to have become specially developed in connection with this posterior lobe and its ciliated canal. Similar glandular cells also form a characteristic feature of the posterior brain-lobes of Schizonemertea and Hoplonemertea. In *Carinina* it is evident that these glandular cells are derivatives, or at least morphological equivalents, of the deeper glands *Gi*, of the integument.

The nerve-cells themselves, out of which the brain is built up, still undoubtedly belong to the integument, and it is exceedingly difficult, if not impossible, to draw a sharp distinction between the outermost brain-cells and the surrounding integument-cells. In the figures just cited this difference has been artificially very much accentuated in order to bring out more distinctly the outline of the brain; for the same reason, the integument in this figure was on purpose not fully worked up.

The inner core of the brain is fibrous, so is the core of the longitudinal stems, where, however, the attempt at a distinction between nerve-cells and cells of the surrounding integument is equally hazardous (Pl. III. fig. 8). This fibrous core is in direct continuity with the nerve-plexus, that spreads out in the deeper integumentary layers.

A vagus nerve passing from the lower portion of the brain on both sides towards the œsophagus is also distinct in *Carinina* (Pl. VI. fig. 1, *Nv*). The passage of contractile fibres through the brain-substance is unmistakable, though less evident than in *Carinella*.

Passing on to the description of the nerve-centres of *Eupolia*, we immediately recognise the difference resulting from the fact that here the brain is imbedded inside the muscular layers, as is also the case in all Schizonemertea.

Our description of the brain of *Eupolia* may be based upon the figures of Pl. V., which were obtained not *de visu*, but by reconstruction from a series of sections.[1] Figs. 1–4

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[1] For the making of these and many other series of sections, and for assistance in the reconstruction above alluded to, I am indebted to the kindness of Dr. Oudemans, my former assistant, now director of the Zoological Garden at the Hague.

and 8 represent the whole of the brain tissue, figs. 5–7 and 9 the fibrous core, as it is enclosed by the nerve-cells, the limit of this cellular investment being given in outline in the latter figures. It must, however, from the first be remarked, that this outline should be completed by the plexus, and by the median medullary nerve. They are not indicated in these figures, although both of them are found along the whole length of the lateral nerve-stems, and reach forward as far as the region of the dorsal brain commissure.

It is seen at a glance that the fibrous core repeats the external folds and prominences of the brain-masses, that the lateral nerve-stem is continued into the lower lobe, and that the upper lobe is distinguished by a prominent fold of its surface, a gyrus (fig. 1, *SL*), into which a separate knob of the fibrous core is seen to pass, and by two other fibrous projections—the one stretching towards the blunt end of the posterior lobe, the other running forwards and accompanying the ciliated canal, which is also marked in outline in fig. 6, and (in red) in fig. 5. The canal *cc*, in figs. 2, 3, 4, 8, is the exterior portion of this duct. The different thickness of dorsal and ventral brain commissure may be gathered from figs. 1, 3, 8, 9; from the latter two, the fact that the nerve-fibres are very strongly preponderant in these commissures over the cells. Close behind the ventral commissure the nerve for the œsophageal wall, *vg*, the so-called vagus nerve, is seen to leave the common fibrous core of the brain, whereas the nerves for the proboscis (*pn*) spring from the inner surface of the ring, where the fibrous core turns up from the ventral to the dorsal commissure (figs. 5, 9). The vagus nerve is soon after its origin connected by transverse fibres with its opposite neighbour; this vagus commissure is sometimes repeated; it will be again referred to in the general considerations on the nervous system. The cephalic nerves that leave the brain and innervate the head are only very imperfectly rendered in these figures; their number is far greater than might be concluded from figs. 5, 6, *an*.

The aspect of several portions of the brain of *Eupolia*, in transverse section, is represented in Pl. VI.

It will there be noticed that fig. 4 represents an anterior section through the inferior brain commissure and the point of innervation of the proboscis, fig. 5 one just behind this, cutting the dorsal commissure and the vagus root at the same time. The exact situation of these sections will be best understood by comparing them with Pl. V. fig. 9, where the respective positions of the commissural ring, the proboscidian nerve, and the vagus are clearly indicated. Fig. 7 is a transverse section lying further backwards, almost in the level where the dotted line, *SL*, in Pl. V. fig. 4 terminates, whereas the section fig. 8 lies again somewhat behind this, at a point where the "gyrus" of the superior brain-lobe actually divides the central fibrous nerve-substance into an upper and a lower portion. These sections, at the same time, show the difference in size between the brain-cells and the glandular elements partaking in the constitution of the brain, along the superficial part of what I have called the posterior brain-lobe (side-organ, *auct.*).

The brain of the Schizonemertea was fully discussed in a former publication (IX). The Challenger Schizonemertea all conform to this type, with the additional facts alluded to above in connection with the medullary nerve. The difference in the size of the ganglion cells in different regions of the brain, as it appears in Pl. XII. figs. 7, 8, and Pl. XIII. fig. 1, is much more marked in certain species of *Cerebratulus* than in others. The larger sized nerve-cells appear to be principally peripherally and anteriorly situated; that they are absent, or less numerous, in certain other species, may be seen by comparing Pl. XII. fig. 1, with the above mentioned figures. The relative distribution of fibrous and cellular nerve-matter in the brain need not be any further described in detail after our foregoing description and figures of *Eupolia*. The size and shape of the posterior lobe is, however, somewhat different in the Schizonemertea. This will be obvious by comparing pl. i. fig. 1 of the treatise referred to (IX) with our present figures of *Eupolia*.

Not having been able to study any of the Challenger species alive, we should have to be content with reconstruction from section series, if I were to enter more fully into the discussion of the respective differences, and for that reason I wish to restrict myself to these general remarks.

One other point connected with the posterior lobe and its ciliated duct deserves special mention, viz., the observation I was able to make that the duct which leads from the bottom of the cephalic slits into the nerve-tissue of the posterior brain-lobe (inside the brain-lobe it very generally has an S-shaped, and, at the same time, a spiral twist, thus being very often as in Pl. XIV. fig. 6, cut in three places, all in one section), and which is clothed in the neighbourhood of its external opening with an epithelium directly continous with, and similar to, that of the outer surface, not only shows certain differences in its epithelium, as we pass further inwards (Pl. XIV. fig. 11), but also offers certain complications, which we have now to consider. These complications very distinctly concern the participation of deeper cellular layers of the integument. As indicated by *gl* in Pl. XIV. fig. 11, these deeper layers segregate and form a ring-shaped or cushion-shaped addendum to the simple epithelial tube. It must be doubted whether they communicate with the exterior, as do the deeper glands of the integument, although this deserves special attention, because of the glandular significance which must be attached, according to Dewoltezky (II), to the strongly refractive cells present on the posterior surface of the hinder brain-lobe (*cf.* p. 94). The epithelium has undergone still more considerable alteration when it passes inside the posterior brain-lobe. Its nuclei are distinct (Pl. XIV. figs. 6, 7, 8), but instead of direct cell partitions we may observe a fine striation vertical to the axis of the ciliated canal (fig. 8). This feature, known to former observers (IX, figs. 35, 36), may here be more especially alluded to, because in Hoplonemertea (Pl. XIV. fig. 10) we find that the discharge of glandular products from the deeper gland-cells takes place between the interstices of this striated region. This discharge into the lumen of the canal is a point that is put beyond doubt by numerous Challenger sections.

The fact that the canal is single in the Schizonemertea, whereas it is double in the Hoplonemertea, was known before (IX). It was also found to be confirmed in all the Challenger species; the bifurcation of the canal taking place in such a manner, that the one branch passes through the distinct nerve-cells, forming the greater mass of the lobe, whereas the other one immediately penetrates—more peripherally—amongst the much larger glandular cells overcapping the foregoing. *Carinina* corresponds with the Schizonemertea in having the canal single.

Having considered the central fibrous substance of the brain in the Palæonemertea and Schizonemertea, we have only to add that the Challenger Hoplonemertea have also confirmed the fact that here this fibrous core is less complicated, the brain-lobes being at the same time more compact, the cephalic nerves very numerous. In *Cerebratulus angusticeps* (Pl. XIV. fig. 6) the fibrous core is very massive and conspicuous also. As to the innervation of the numerous eyes, I have no new observations to record (*cf.* V and IX), nor as to that of the proboscis, with the exception of the fact that in *Drepanophorus* and *Amphiporus* I could distinguish numerous nerves springing from the brain-ring and corresponding to the numerous longitudinal trunks in that organ. This point, which was left in doubt by v. Kennel (XVI), is thus definitely settled. The phenomenon was particularly distinct in one specimen of *Amphiporus moseleyi* that had retained its proboscis. It has only been partly figured in Pl. IX. fig. 10, where only two are indicated, so as not to obscure the diagrams.

As to the innervation of the œsophagus, little need be said as far as the Schizonemertea are concerned, the well-known strong and double vagus nerve being constantly met with. Distinct nerve-branches are seen to take their course in the walls of the œsophagus (Pl. XIV. figs. 3, 4); it was already noticed above (p. 79) that these may be partly traced to separate branches springing independently from the nerve-plexus, whereas for the other part they are ramifications of the so-called vagus.

Nerves to the intestinal canal, very easily detected in the œsophageal region, could not be traced with the same accuracy and distinctness in the post-œsophageal region of the intestine, most probably owing to the extreme tenuity which these fine and delicate nerve-twigs may here have obtained. It cannot be determined at present whether this portion of the intestine also receives branches from the œsophageal vagus system or only directly from the plexus, now that the existence of such a double method of innervation (*Cerebratulus corrugatus*) has been actually demonstrated for the anterior regions of the intestine. On *a priori* grounds, I look upon the latter arrangement as by far the most probable.[1]

The course of the vagus is somewhat modified in *Drepanophorus*, and perhaps in *Amphiporus*. I find the strongest nerve-stem, connecting the brain with the œsophagus, in *Drepanophorus*, running forwards instead of backwards (Pl. IX. fig. 10). Other smaller

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[1] It should here be noticed that Kleinenberg (*loc. cit.*, p. 114) has also failed to detect visceral nerve-branches to the endodermal intestinal epithelium of the Annelid, *Lopadorhynchus*.

stems leave the brain in corresponding regions of the lower brain-lobe, *i.e.*, along the surface turned towards the proboscidian sheath, and run in the direction of the œsophageal epithelium. This secondary innervation, though different in morphological aspects, is more or less homologous with the facts above disclosed in the case of *Cerebratulus corrugatus*. That the vagus proper—the massive and thick stem—is here turned forwards may be a consequence of the change in the situation of the mouth, which in the Hoplonemertea is no longer behind the brain, but in front of it. This gradual change of position may very possibly have drawn the vagus-stem with it. In concluding our remarks upon the brain I have only to add that the well-known difference between Schizonemertea and Hoplonemertea with respect to the connection between anterior and posterior brain-lobes (side organs) also obtains in the Challenger specimens. The latter are connected in *Drepanophorus* and *Amphiporus* with the brain by one or more fibrous commissures.

Another difference several times observed between the fibrous brain-tissue of these two Hoplonemertean genera on the one hand, and *Cerebratulus*, *Eupolia*, &c., on the other, is a marked increase in compactness of the fibres, so much so that the fibrous character of the central portions of the brain has often more the aspect of Leydig's "Punktsubstanz," and even shows a still more delicate and more compact texture by the appearance in this "Punktsubstanz" of regular patches with very faint outlines, which apparently are still more compact regions of this tissue.

The longitudinal nerve-stems, which are the posterior continuations of the lower brain-lobes, hardly need any special mention. It must only be insisted upon that in them, as well as in the brain-lobes, there is no absolute distinction between the cellular envelope and the fibrous core, but that inside this core nuclei are invariably scattered, which bear testimony to the absence of any such definite boundary. Still, there is generally a homogeneous and very thin layer between the cellular coating and the fibrillar core, a kind of membranous neuroglia, through which the fine processes of nerve-cells may be seen to take their course in groups, which then become lost amongst the fibres of the core. Then, again, certain favourable sections (Pl. XII. fig. 2) very distinctly show the course of nerve-fibres inside this fibrous core that are not longitudinal, and thus punctiform in transverse sections, but that are interwoven at right angles with the latter and continue their way into the nerve-plexus. The transparent sheath of the fibrous core of the nerve-stem is more distinct in *Cerebratulus* than in either Palæonemertea or Hoplonemertea. It is rarely encountered in the brain, where fibrous and nervous elements are more intimately interwoven (*cf.* Pl. VI. figs. 4–8; Pl. XII. figs. 7, 8; Pl. XIV. figs. 7, 8).

Outside of the stems there is another accumulation of homogeneous connective tissue arranged as a protecting envelope round the nerve-stems. This is much more conspicuous in the brain-lobes, and more so in the Hoplonemertea (Pl. XII. fig. 5) than in the Schizonemertea (Pl. XII. fig. 2; Pl. XIV. fig. 2). Still in the latter it is far more conspicuous than in *Carinina*, where we have already pointed out the apparent absence of any sharp or distinct boundary line between the cellular brain-tissue and the surrounding cellular tissue of the integument.

We cannot pass on to the description of the peripheral nerves without first referring to the terminal portion of the lateral nerve-stems, known to terminate at the posterior end of the body, right and left of the anus in the Schizonemertea, but also known to meet in a connecting commissure *above the anus* in several Hoplonemertea (IX). This commissure was found by me in several Challenger species, but at the same time I was able to verify the unexpected fact that in *Eupolia* the fibrous cores of the longitudinal nerve-stems are also posteriorly united by a commissure. What most especially deserves attention in this posterior commissure of *Eupolia* is, that it is found *below the anus*, the longitudinal stems and the commissure, together with the brain, thus forming an immensely elongated ring round the intestine, whereas in most of the Hoplonemertea alluded to, all the portions of the nerve-system may be said to remain above the intestine. This is, indeed, very emphatically the case in *Amphiporus moseleyi*, where we find (Pl. IX. fig. 4) not only the brain and the anal commissure above the intestine, but also the longitudinal stems, that take their course above the intestinal cæca. Nevertheless, in *Drepanophorus* the anal commissure is above the intestine, although here the longitudinal stems are diametrically opposite in position, *i.e.*, below the intestinal cæca. They were for this reason considered (IX) to furnish a transition stage to the ventral cord and circumœsophageal ring of Annelids and Arthropods, a consideration which derives very strong support from the existence of transverse commissures that will hereafter be described. At all events, these very curious differences—the anal commissure of *Eupolia* is figured on Pl. VII. fig. 8—furnish another proof of the extraordinary plasticity which we meet with in the group of the Nemertea, with respect to the morphology of the most important components of the system; a plasticity and diversity which are at the same time indicative of the primitive and low scale on which the Nemertea may be said to find themselves.

Coming now to the peripheral nerve-system, I may note that I have already, some years ago (X), stated that it is difficult to apply this name in its generally accepted significance to the arrangement which we find in Schizonemertea and in Palæonemertea. It is, however, applicable to that of the Hoplonemertea. Here only we find distinct metamerical peripheral nerves leaving the longitudinal nerve-stems at regular intervals, and innervating the body musculature, the integument, the internal organs, &c.

In the Schizonemertea and Palæonemertea the cephalic nerves, starting from the brain, are directly comparable with those of the Hoplonemertea, but the rest of the peripheral system is here represented by the plexus and its innumerable branches and twigs, which are directed upwards and downwards, serve for the same purpose, and render the peripheral arrangement in this group so primitive and so important. Still, in very large specimens of Schizonemertea (Pl. XIV. fig. 2) I could observe that from the thickened part of the plexus, which forms the longitudinal stem, fine nerve-branches also take their origin, and pass directly to the periphery. The essential difference between Schizonemertea and Hoplonemertea in this respect nevertheless remains the same as above formulated.

We may now turn to the Hoplonemertea. The different species contained in the Challenger collection confirm the well-known facts about the metamerically placed pairs of peripheral nerves of the Hoplonemertea, some of which are turned dorsally, others ventrally, and which, dividing dichotomously, finally spread out in very numerous bundles of nerve-fibrils, serving for the innervation of the environing regions. In addition they also furnished me with certain important new points. To begin with the latter, I will first draw attention to the two longitudinal nerve-stems of *Drepanophorus lankesteri*, which are situated, as is characteristic of this genus, below the intestinal cæca (Pl. IX. figs. 1, 5, 6), about midway between the lateral margin of the body and the median ventral line. These stems in transverse section very much resemble those of other Hoplonemertea. One of them is figured on Pl. XII. fig. 5; from this it may be seen that the nerve-cellular coating is generally not distributed as a sheath all round the fibrous core, but as a double band applied upon this core at two diametrically opposite points. The participation of this cellular coating in providing the outgoing peripheral nerves with delicate nerve-fibres is distinctly seen in this section, as is also the direct continuity of other portions of the peripherally directed nerve-fibres with those of the core.

When in *Drepanophorus lankesteri* I followed some of these peripheral nerves in their further course, by examining the consecutive sections in which they are continued, I was struck by the very remarkable fact, never noticed before, that some of them did not dichotomise—or at least very rarely—and did not taper towards the periphery, but passed directly under the intestine from the one longitudinal nerve-stem into the other, a distance in this specimen of $1\frac{1}{2}$ mm. This was an unmistakable commissure, which could in no way be compared to the well-known commissure above alluded to, which connects the two longitudinal stems above the anus. And not only was one such ventral commissure present, but on closer inspection I found a great number of them, and by registering the respective distances at which they were present, the one behind the other (about $\frac{1}{7}$ mm.), I was forced to the conclusion that we here have before us a system of very regular metamerically placed commissures between the longitudinal stems, and forming a nerve-ladder (Pl. IX. fig. 10), which is very directly comparable to that of *Sabella* and other species among Annelids, and to that of *Proneomenia* and *Chiton* among Molluscs. In a few of these commissures I detected dichotomy and fusion of one of the branches thus formed with the foregoing or with the following commissure, a peculiarity also known to exist in *Chiton*, but evidently of rarer occurrence in *Drepanophorus lankesteri*. Moreover, I may also mention that in certain commissures it was clear that fine nerve-twigs spring from them and serve to innervate the surrounding tissues, their significance thus not being solely commissural. The different facts just recorded are represented semi-diagrammatically on Pl. IX. fig. 10, which was reconstructed from the very large number of sections which I have of this species. It is, moreover, seen in this reconstruction how other peripheral nerves spring from the longitudinal stems as well, some being directed upwards or downwards, some towards the side or inwards. These peripheral stems are metamerical, as are the commissures, a metamery which, though not absolute, and sometimes broken by certain irregularities, is still more advanced towards perfect regularity than is the incipient metamery which we observe in the nerve-tracts that are noticed inside the plexus of the Schizonemertea, and that were more fully described above. The transverse commissures between the lateral stems may be noticed to go up quite close to the brain-lobes, as indicated in the diagram on Pl. IX. fig. 10. Both in this respect and in the fact of their existence, they call to mind the ventral commissural tracts in the plexus of Schizonemertea. I have no doubt that the two systems are homologous, the commissures having subsisted in *Drepanophorus lankesteri* although the plexus has disappeared. Finally, it must be mentioned that as yet I have looked for them in vain in other species of *Drepanophorus*, or in other Hoplonemertea. My other specimens of *Drepanophorus* are, however, less well preserved than is the one specimen of *Drepanophorus lankesteri*.

Another peculiar feature of the peripheral nerve-system of the Challenger Hoplonemertea, which has also remained hitherto unnoticed, is most favourably observed in *Amphiporus marioni*, although I afterwards noticed it in other Hoplonemertea. It is figured on Pl. X. fig. 1, *ne*, and consists in the fact of a peripheral stem, which has taken its outward course away from the longitudinal nerve-trunk, and which has penetrated amongst the pennate fasciculi of longitudinal muscle-fibres of the layer α, spreading out in a plane parallel to that of the body-surface, and thus forming a kind of local plexus between the muscular layers α and β. It must for the present remain an open question whether this arrangement, which can be noticed in different regions of the same section, and which in no section was absent, must be regarded as a primitive feature connected with the plexiform arrangement which must have obtained in the ancestral forms of the Hoplonemertea, or whether it is merely a special adaptation, having arisen in certain Hoplonemertea, and being in some way subservient to the innervation of the muscular investment or the integument. At all events it is a peculiar arrangement, and, as such, deserves special mention.

How intricately and yet how regularly the peripheral nerve-system of the Hoplonemertea may be said to be distributed can also be gathered from Moseley's figure of *Pelagonemertes*, which we have copied on Pl. I. fig. 23, where the peripheral nerves are seen to spring, two at a time, from the lateral trunks, which here, too, are united posteriorly by a commissure above the anus.

One peculiarity, finally, deserving special mention is the presence in the majority of well-preserved specimens of Hoplonemertea of a medio-dorsal longitudinal nerve homologous to the medullary nerve described above (*cf.* p. 81, and Pl. XI. fig. 8). Its connection with the rest of the nervous system could not be satisfactorily made out, although traces of a connection with the dorsal brain commissure were not wanting in many specimens. Its presence is, however, significant, and its retention in the Hoplonemertea, where the arrangement of the nerve-system has so considerably deviated from the primitive Palæonemertea and Schizonemertea, must prevent us from underrating its morphological significance. This will be more fully entered into in the chapter of General Considerations at the end of this Report.

SENSE-ORGANS, ACCESSORY GLANDULAR STRUCTURES, AND ORGANS OF UNKNOWN SIGNIFICANCE.

The most conspicuous sense-organs of the Nemertea are without doubt the eyes. Although eyes are absent in very many genera and species, and although in some species pigment spots at the tip of the snout are regarded as such, other genera have very well-marked and numerous eyes, with a hyaline hemispherical refractive body, a layer of visual rods, and an optic nerve connecting the eye with the brain-lobes. These more highly-developed eyes were previously known to occur in the Hoplonemertea, and the Challenger material has confirmed these general conclusions. The most primitive of the Palæonemertea, *Carinina*, is not provided with eyes. Nor do I find traces of eyes in those species of *Eupolia* which were contained in the collection, and of which the head was studied in sections. *Eupolia giardii* is among these. However, it is known from other researches (VII) that different species of *Eupolia* have often very numerous eyes, increasing in number with the growth and the age of the animal, and, moreover, that these eyes resemble those of the Hoplonemertea in many respects. Nor were the Schizonemertea of the Challenger provided with eyes that revealed their presence in the microscopic sections, although I would not venture to affirm the total absence of eye-like structures or pigment spots. In this respect the fresh animal often shows at a glance what is very difficult to demonstrate in the series of sections, *e.g.*, the number and disposition of the eyes or pigment spots. As, moreover, these data can hardly be of any taxonomic value for the determination of the Schizonemertea, I think I may pass on to the discussion of the eyes of the Challenger Hoplonemertea.

They have the characteristic histological arrangement already described and figured by myself in a former publication on the subject (IX, fig. 42). A posterior layer of rod-like elements, which is in direct connection with the optic nerve, is enclosed by pigment, and the whole completed into a more or less oval cup-form of which the anterior part shows very distinct cellular elements with nuclei. Distinct lenticular structures, which were formerly noticed in Mediterranean Nemertea, could not be certainly made out in the Challenger specimens. What varies most is the pigment coating the posterior hemispherical surface. Sometimes this pigment is intensely black, and so extremely fine that it looks almost homogeneous (*Amphiporus moseleyi*), whereas in other cases (*Amphiporus marioni*) the pigment granules are uncommonly coarse and large sized, the colour being in this case a brownish-green rather than black.

In discussing the further sense-organs of the Nemertea, a great significance must certainly be ascribed to the sensory elements distributed in the skin, and primarily serving for tactile functions. With respect to this organ of sense, the spirit specimens at my disposal have, however, revealed no new facts of importance. I have only convinced myself—as has been already noticed both when describing the cellular integument and its innervation—of the presence of distinct sense-cells in all parts of the integument. They have the well-known form of the sense-cells described by the Hertwigs, by Lang, and by others in the Cœlenterata, in the Platyelminthes, &c., and it is to them that the extreme delicacy of the tactile sense, which is revealed in living specimens of Nemertea, must be ascribed. Bateson's fig. 77 [1] of *Balanoglossus* comes very close to what was observed in the Nemertea in connection with these sense-cells. Their direct innervation by nerve-fibres, starting radially from the plexus in the two more primitive groups, has been noticed above (*cf.* Pl. XIII. fig. 6 ; Pl. XIV. fig. 2). Sense-cells with distinctly longer and stiffer hairs, such as I have been able to observe in living specimens from the Bay of Naples, have not come under my notice in the Challenger sections. The similarity with *Balanoglossus*, just alluded to, is increased if we consider Bateson's figs. 70, 75, and 79, and compare them with the integument of *Carinina*. The similarity is significant. In sections of *Balanoglossus* made by myself I was very much struck by this resemblance, reaching from the cilia down to the nerve-plexus and subjacent muscles.

Another question I wish to allude to here, and which has been pressed upon me by certain of the Challenger specimens, is whether the terminal transverse furrow which is encountered at the tip of the head in *Carinina* (Pl. I. fig. 1–3 ; Pl. II. fig. 1), which is also distinctly seen in certain *Amphipori* (Pl. IX. fig. 9), has not also primarily a tactile significance. And, in addition to that, I wish to ask whether we might not look upon this terminal groove, which lies more or less in a horizontal plane passing through the animal, as having preceded the paired longitudinal cephalic furrows which form the distinctive feature of all the Schizonemertea. When considering the probability of this suggestion, the following points should not be lost sight of—(1) that in certain *Cerebratuli* these cephalic furrows do meet at the tip of the head (Pl. I. figs. 13, 14, 18, 19) ; (2) that the furrows in this case are comparatively short (figs. 13, 14) ;

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[1] *Quart. Journ. Micr. Sci.*, June 1886.

(3) that in *Carinina* the opening through which the proboscis is everted lies ventrally to this furrow; (4) that in most *Cerebratuli* the proboscidian opening would similarly lie ventrally to the point of meeting of the lateral cephalic furrows if we supposed these to meet at the tip of the snout; (5) that in a few cases the opening appears to have shifted into the central part of the fissure; (6) that in other *Cerebratuli* the fissures, though continued on the anterior and apparently truncated portion of the snout, do not wholly fuse (Pl. I. fig. 12), but that just in the interval the proboscidian opening is situated; (7) that again in other *Cerebratuli* this anterior truncated portion is wholly devoid of any continuation of the fissures, which in their turn may be exceedingly deep and long (Pl. I. fig. 16); (8) that in the *Amphipori* alluded to (Pl. IX. fig. 9) the common opening for proboscis and digestive cavity is also situated ventrally to the terminal fold; (9) that in *Eupolia* transverse and very shallow cephalic fissures are found, which very strongly resemble those of the Hoplonemertea (even in the presence of short and numerous secondary grooves perpendicular to the principal groove), and which similarly contain the opening that leads into the posterior brain-lobe, as is the case in *Carinina* and the Hoplonemertea, and that even yet in certain *Eupoliæ* a trace of a terminal horizontal furrow has been retained (Pl. I. fig. 7).

Tabulating these different facts, the case would appear to stand thus :—

Carinella annulata,	one terminal shallow horizontal groove, two transverse lateral ones, no ciliated canal.
,, *inexpectata*,	(VIII) terminal groove uncertain, transverse lateral grooves, ciliated canals into the brain-substance opening out into these grooves.
Carinina,	terminal groove present, lateral grooves, with openings of ciliated canal leading into a separate posterior brain-lobe.
Amphiporus,	terminal groove present, lateral grooves, with openings of ciliated canal leading into a separate posterior brain-lobe.
Eupolia,	hardly a trace of terminal horizontal groove, lateral grooves as in the Carinellidæ and Hoplonemertea.
Valencinia,	no grooves at all, simple round opening for ciliated canal.
Schizonemertea,	two longitudinal (never transverse!) cephalic grooves which in some cases are wholly separate, in other cases meet at the tip of the snout, and might then in their entirety be compared to a terminal horizontal groove such as that of *Carinina*.

If the latter conjecture be true, *i.e.*, if we may suppose the lateral furrows of the Schizonemertea to be derived from an ancestral phase, in which a terminal groove like that of *Carinina* was separated into two halves which deepened and widened on both sides of the head, reaching down as far as the opening of the ciliated canal into the posterior brain-lobe, then, indeed, *Carinina* may be said to represent—also with respect to the fissures and grooves on the head—a stage of development in which both the characteristic features of the Hoplonemertea and the Schizonemertea are still present in combination. In deviating from the original arrangement, the Schizonemertea would have gone a longer way than would the Hoplonemertea, some of which still answer to the original type of structure found in *Carinina*.

I now wish to consider more closely certain details of these different cephalic fissures, which cannot be discussed in a more appropriate place than in the section treating of the sense-organs, although their exact significance must for the present remain unsolved. In spirit preparations the ciliated coating of the body is generally never better preserved than in these furrows; and the cells carrying the cilia, as well as their nuclei, are in most cases exceedingly distinct. However, in a few cases it is only the superficial layer of the integument that is thus continued as a clothing of the inner surface of these furrows. In most cases I could observe the deeper layer of integumentary glands (Schizonemertea) to be continued, although less compact, along the whole inner surface of the cephalic slits. Generally these deeper glandular layers appear to have undergone some special modification in connection with the canal that opens out at the bottom of the furrow, and leads into the brain-substance, a modification which may already be noticed in so primitive a genus as *Carinina*, which, however, with respect to this apparatus, may be said to be more differentiated than the allied genus *Carinella*.

We find in *Carinina* (Pl. VI. figs. 1–3) that all round the bottom of this groove (*Cg*) there is a marked increase of the number of nuclei in the integumentary tissue; and although these nuclei can scarcely be said to belong to the layer of the deeper glands (*cf.* Pl. IV. fig. 1 *E*, and the paragraph on the integument), but rather to the one exterior to this, the fact of their accumulation in this marked way, just along the inner surface of the cephalic groove, is a most reliable indication that the integument is in some way modified in adaptation to the significance of these grooves. In Pl. VI. fig. 1 a distinctly pointed shape is assumed by this wedge-like or horse-shoe-shaped accumulation of nuclei, and a fibrous band connecting them with the intermuscular tissue is even visible, more or less clearly, separating—at least in this section—a posterior brain-lobe *Br′*, into which the canal passes, from the anterior brain-mass *Br* (*cf.* woodcut, p. 81). The glandular layer is, however, not indifferent or neutral during these changes in the exterior nuclear one; and although the two specimens at my disposal do not permit me to unravel the whole of the modifications it undergoes, I may still be permitted to observe that in figs. 2 and 3 of Pl. VI. its participation (*Gi* and *gl.br*) cannot be denied, whereas a comparison of all the three figures here given makes it appear very probable that these glandular elements (*gl.br*), derived from the deeper layer of the integument (*Gi*), play a part with respect to the posterior brain-lobe of *Carinina*, which may best be compared to the glandular investment of the posterior brain-lobe, as it is encountered in all the other Nemertea (*cf.* Pl. VI. figs. 7, 8; Pl. XIV. figs. 6–8, 11). What the physiological meaning of this glandular investment may be must remain unsolved for the present, although we will return to this question further on. *Carinina* demonstrates that, as the brain-lobes are direct derivatives of the integument, so is the glandular investment of the posterior one. I may here note that, in studying the development of *Lineus obscurus*, I have (**XIV**) been able to determine the fact that the glandular investment and the nerve-cells of the posterior brain-lobes also arise in that species out of the same mass of embryonic cells. Moreover, I must add that the glandular significance of this investment was for the first time more emphatically brought forward by Dewoletzky in a short notice on the Nemertea (**II**). Although I cannot accept all the conclusions to which this naturalist arrives with respect to the apparatus of which we are here treating, and must demur when he rejects the specially adapted respiratory significance which the brain canal must necessarily have in very many species, still it is only fair to call attention to his inquiry into the nature of this cellulo-glandular investment.

The only point which has still to be noticed, and which is partly a repetition of what has been already described in the paragraph on the nervous system, is the fact of the actual observation by myself in *Drepanophorus lankesteri*, from the Challenger collection, of the passage of the contents of part of these glandular investing cells into the lumen of the canal (Pl. XIV. fig. 10). Moreover, one point should not be lost sight of, viz., that between the glandular cells that form an actual investment of the posterior lobe (and which in *Carinina* could be identified with the deeper glandular structure of the integument) and the actual integumentary glands, there exists in Schizonemertea a constant and considerable difference, even with respect to the affinities for staining reagents, and still more in the general aspect. The case of *Carinina* is on this account all the more interesting. We must only be careful not to look upon the exceptional case which I was able to observe and to figure (Pl. XIV. fig. 11, *gl*), in which an additional glandular (?) ring surrounds the ciliated canal after it has passed out of the brain-lobe on its way to the exterior, as one of transition. I hardly think that this special adaptation, which has been already noticed above (p. 60), pertains to the layer of the deeper skin-glands; and though I am not prepared to offer a definite opinion, I am much more inclined to compare this curious accumulation of distinct and nucleated cells with a similar accumulation which we have also noticed in *Carinina*, and have there encountered more peripherally but still surrounding the ciliated canal (Pl. VI. figs. 1–3). In either case the physiological significance of the arrangement cannot at present be decided.

And to a certain extent this may also be said to be the case with respect to the whole of the posterior brain-lobe. As long as it went by the name of side-organ—which, however, did no justice to its intimate connection with the brain—it was generally regarded as a specific sense-organ of unknown function (Quatrefages, M‘Intosh, &c.). Later on I published a paper (**IX**) in which the attempt was made to show that, in a very large number of cases, the ciliated canal is adapted to give the oxygenated sea-water access to the hæmoglobiniferous nerve-tissue. At the same time (*loc. cit.*, p. 35) I did not deny all sensory significance to the organ, but repeated that we had not found any specialised sensory epithelium in it, and could not judge of what kind the sensory impressions might be that were carried by the apparatus to the animal's sensorium. Since then I have been able to fix the exact mode of origin of the apparatus in at least one species of Nemertea (**XIV**, **XV**), and may here recall to mind that the central lining of the canal most decidedly takes its origin as an invagination of the epiblast. This invagination secondarily coalesces with the brain. In these two ontogenetic data we have only very vague indications. They allow of a comparison both with olfactory and with auditory pits. Strange as it may seem, I do not see that the first comparison has many more *a priori* arguments for it than the second. Otoliths, it is true, have not been found in this lobe, but who can tell what purpose the minute concretions, formed by the ensheathing gland-cells, and sometimes accumulated inside the lumen of the canal, may serve?

We have, however, to suspend our judgment. Graeffe's, Keferstein's, and Claparède's observations on the existence of special otolith capsules in the Nemertea require further confirmation. They may, perhaps, have mistaken the highly refractive globules in the gland-cells of the posterior brain-lobe for otoliths.

One more point may be mentioned, viz., that the comparison of the cavity of these lobes with a branchial slit of *Balanoglossus*, &c. (*cf.* Bateson, *loc. cit.*), which I tentatively attempted in a former paper (**IX**, p. 33) has to be definitely abandoned, now that the epiblastic origin of the cavity has been indubitably shown by myself and afterwards by Salensky (**XIV**, **XXX**), and since on this point the statements of earlier authors as to the hypoblastic origin of this cavity (Barrois, &c.), which led to my former suggestion, have to be definitely abandoned.

If the comparison with a gill-slit is no longer tenable on morphological grounds, this in no way changes my views as to the physiological importance that must be attached to the direct respiratory function of the nerve-tissue, which can nowhere be so perfectly accomplished as in the posterior canalised lobe. I have no doubt, however, that in some species—more especially of Hoplonemertea—its significance as an organ of sense may supersede its importance as a respiratory chamber, the hæmoglobin, though present in these species, being there much more diluted, at any rate colouring the brain less intensely red, and the connection between posterior and anterior lobes being at the same time less intimate.

Having now discussed all those parts of the organism which we have any—though sometimes even questionable—right to consider as sense-organs, I must pass on to those which are of a still more dubitable nature, and which fall under the head for which the further part of the superscription of this section was intended.

Since in some cases I find them in the head and directly innervated by the brain, since in another case they are at the sides of the head stretching backwards for a not inconsiderable distance, but always exactly at the lateral margin, and because a glandular epithelium plays an important part in their constitution, there is indeed some, though of course very distant, analogy with the glandular parts of the posterior brain-lobes which we have considered before. I do not wish to attach any importance or significance to this analogy for the present, for we have no sufficient data; but I mention it by way of explanation as to how I come to intercalate the description of these parts of the organism in this place.

The first structure which I have to mention occurs in the head of *Drepanophorus lankesteri*, and something analogous to it was noticed by former observers (**XVI**) in *Geonemertes palaeensis*. In the Challenger specimen the horizontal sections through the precerebral region demonstrate, when viewed with low powers, the presence of a lobulated mass which is imbedded in the gelatinous ground-substance and partly traversed by contractile fibres that radiate through the head in so many directions. When higher powers are applied, this mass is dissolved into groups of cells enclosing more or less circular free spaces, which, being present in consecutive sections, represent a system of canals coated by the cells just mentioned, the whole forming a kind of spongy tissue. A branch by which this canalicular system communicates with the exterior could not be made out in my specimen, although von Kennel has found such an opening in his *Geonemertes*, and thus I do not wish to lay too much stress on the fact of my being unable to rediscover it in the only Challenger specimen in which I found this structure. The cells are much more granular and at the same time larger than the surrounding cells of the intermuscular gelatinous mass; the nuclei are large and distinct (Pl. XV. fig. 13). It must be noted that the character of the cells and the aspect of the organ differ very essentially from von Kennel's description. It is the situation that is correspondent.

A similar precerebral glandular lobulated organ was found by me in *Drepanophorus rubrostriatus* from the Mediterranean, though not in the Challenger specimens of this species, in which, as was remarked above, the head was deficient. A special innervation by nerve-fibres belonging to the cerebral nerves was in both cases made out.

The second structure to which I alluded as occurring in Challenger Hoplonemertea was found by me in the different specimens of *Amphiporus moseleyi*, both in transverse and horizontal sections. It may shortly be characterised as being an accumulation of short, saccular tubes, blind posteriorly and opening to the exterior by a distinct neck, which pierces muscular layers as well as basement membrane, its internal epithelium then fusing with the integument. These short flask-like sacs sometimes internally coalesce with each other, the same interior cavity then communicating outwards by more than one duct. This, however, appears to be more or less exceptional. They are very numerous, though short, at the tip of the head (Pl. X. fig. 3, *gl.s*). They become larger when we follow them further backwards, where we find them situated laterally in that region of the body where the dorsal musculature passes into the ventral, and where the intervening layer of muscular tissue is either very thin or even (sometimes locally) absent, at least as a special layer. In every transverse section some three or four of these glandular flasks are simultaneously cut (Pl. XV. fig. 11). They show no further variety of structure, but are not found along the whole length of the body. In the hinder half at least I have not detected them. The histological constitution of these flask-shaped glands is difficult to make out in the spirit specimens. The epithelium clothing them had a very much changed and deteriorated aspect, and only in certain favourable regions could I definitely establish the fact that it was built up of largish cells with large nuclei (Pl. XV. fig. 12), the contents of the cells being granular like those of the cells of the median precerebral organ before described. Innervation was not so clearly traced here, though in the head these flask-shaped organs certainly receive fibres from the very numerous cerebral branches there present.

Having once determined the presence of the organs just described and their situation, it was found that their presence is even externally traceable in the specimens of *Amphiporus moseleyi* (see Pl. IX. fig. 8) by a white line running backwards from the tip of the head along the comparatively sharply edged margin of the body (see pp. 20, 21). When a transverse section is made in this region with a razor, the naked eye can trace this white line extending inwards for a short distance as if the pigment occasioning it were very thickly applied. Viewed with the microscope, it is then easily seen that this white spot breaks up into the accumulated flasks as above described, which are surrounded and supported by the gelatinous tissue. In such a section the latter tissue is much more transparent and homogeneous, thus bringing out the glands as white lateral spots in this transparent imbedding mass, in which also the rest of the internal organs may be seen to be suspended, and which is dorsally and ventrally limited by the body musculature and the integument.

It may finally be noticed that I have never succeeded in finding the necks of these flasks that lead to the exterior wholly free and open, as I have the canal of the posterior brain-lobe or the excretory duct of the nephridia. These very numerous necks of the flask-shaped organs are always filled with a mass that has a streaked and fibrous appearance. I mention this because it partly contributes to establish my conviction that the physiological significance may indeed be glandular, and that the secreted, viscid mass, passing out perhaps more copiously when the animals are immersed in spirit, remains fixed in this passage to the exterior.

If it be not premature—as I consider it to be—to establish any comparison between these organs and parts of the organism of Vertebrates, one would certainly be reminded of those canals in the head which are known as the "Schleimcanäle," and which are continued along the sides of the body as the lateral line. The significance which of late has been more and more definitely assigned to these organs in the Vertebrates, as accessory to the sense-organs forming the system of the lateral line, a sensory epithelium being protected by and combined with them, has no direct parallel in *Amphiporus moseleyi*, although it cannot be denied that the flask-shaped glands are in the immediate vicinity of and on a level with the lateral nerve-trunks.

The absence of these glandular structures in the Palæonemertea and Schizonemertea hitherto observed, renders the suggestion of any close homology very hazardous. Still, I would not wholly refrain from pointing out the distant kind of parallelism which may be noticed, and which has certainly contributed to induce me to consider these organs in the paragraph devoted to the sense-organs, a proceeding which future investigations may perhaps show to have been wholly unfounded. The significance of this parallelism will once more be discussed, when, in the chapter of General Considerations, there is further scope for speculation.

PROBOSCIS AND PROBOSCIDIAN SHEATH.

Concerning this important organ, so very fully described by M'Intosh in his Monograph on the group (**XIX**), the Challenger material has not revealed any startling peculiarities. Nevertheless, it deserves some closer consideration, because certain points, *e.g.*, the exact mode of the anterior attachment of the proboscis in these worms, could be studied more favourably by me in certain of the Challenger sections than ever before. Moreover, the Russian naturalist Salensky has lately[1] propounded certain views concerning the proboscis and its sheath which deserve consideration and refutation.

I will first describe the facts with respect to the proboscis which we notice in the Challenger Nemertea.

Carinina has a proboscis which, in transverse section, reveals the remarkable peculiarity that the primitive order of succession, according to which in the body-wall we meet with (1) integument, (2) longitudinal nerves, (3) musculature, also obtains in the proboscis, the innervation of which takes place through the intervention of two longitudinal nerves, which are so situated as to be enclosed by the internal cellular epithelium (Pl. II. figs. 11, 12), just as is the body nerve-stem in a section of the trunk. This fact, though it cannot be looked upon as a direct confirmation of the hypothesis advocated by me after I had become acquainted with Graff's Monograph on the Rhabdocœla, viz., that in the Nemertea also the proboscis should be looked upon as a gradual derivative of an original continuation of the body-wall, which has become introvertible like the snout of the Rhabdocœla proboscidea, still throws a very favourable light on these views. And this is further the case when we notice that in many Schizonemertea there is also an order of succession of the layers in the proboscis-wall which is

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[1] *Zeitschr. f. wiss. Zool.*, Bd. xliii. p. 509.

similarly more or less a repetition of the same arrangement in the body-wall (Pl. XV. fig. 2, α', β', *npl.*, γ').

In addition to the peculiarity just described, there is another morphological consideration which tends to show that this interpretation of the significance of the proboscis is indeed the right one. When we consider a horizontal section through the region of insertion of the proboscis in the head (Pl. III. fig. 5), we see that in *Carinina* the mode of fixation of the proboscis is exceedingly simple, its longitudinal muscular coat being in direct continuity with the longitudinal muscle-layer of the body-wall. Somewhat in front of the transverse cephalic grooves, about on a level with the anterior brain-lobe, we see certain of the fibres of this longitudinal coat, instead of pursuing their course onwards towards the tip of the head, bending inwards, traversing the space which I have termed (**XIII, XV**) the archicœle, and then running backwards as the longitudinal fibres of the proboscis. Other fibres, parallel to those just referred to, do not contribute towards the formation of the proboscis, but continuing in their original direction, take part in the formation of the muscular wall of the head (Pl. III. fig. 5). It certainly deserves remark that the same comparatively simple arrangement is met with in the much more highly differentiated Hoplonemertea, as a glance at fig. 3, Pl. X. will show. There, too, the longitudinal musculature (a) of the body-wall is partly continued towards the tip of the head, where it partly bends round and largely contributes to the formation of the muscular layers of the proboscis. I suppose this way of stating the facts is more in accordance with their actual relations, than to say that the longitudinal musculature of the proboscis is internally inserted upon that of the body. Here also the direct continuity of body-wall and proboscidian-wall, the latter appearing merely as an inverted portion of the former, is forced upon our attention, as is in the same way the direct continuity of the exterior integument *J*, through that of the rhynchodæum *Rh* to that which clothes the proboscis itself, and which on the eversion of that organ forms the exterior surface.

We must now consider these different parts more in detail. Commencing with the rhynchodæum (*cf.* p. 8), we find in the Palæonemertea and Schizonemertea its walls bathed by the blood-spaces in the head, as may be gathered from a comparison of the figures in Oudemans' paper (**XXVII**) on the blood-vascular system. This is no longer the case in the Hoplonemertea, where these blood-spaces are replaced by the distinct vascular loops. The proboscidian walls, fusing anteriorly with the musculature and the external epithelium of the head, are different in the different subdivisions. Contractile fibres and cellular elements, the materials of which the rhynchodæum is built up, are present in *Carinina* in quite a different relation from that in which they occur in *Cerebratulus* or *Amphiporus*.

In *Carinina*, as a glance at Pl. III. fig. 5 will show, it is the cellular elements (*APe*) that are extremely preponderant. These cells are vacuolated, more than one layer thick, different in aspect from the true proboscidian epithelium, and held together by a fibrous coating, which is attached by radial fibrous bands to the cephalic musculature. The rhynchodæum is thus suspended in the cephalic blood-space, as was formerly (IX) described by me in *Carinella*.

The histological difference between the vacuolated cells of the rhynchodæum of *Carinina* and the cells of the outer integument, is less than that between the former and the epithelium of the proboscis proper.

A comparison between figs. 3, 4 of Pl. III., fig. 1 of Pl. IV., and figs. 1–3 of Pl. VI. will sufficiently demonstrate this, vacuolated cells playing a very prominent part in the outer strata of the integument in *Carinina*. Still the three epithelia (external, rhynchodæal, and proboscidian) are immediately contiguous, the passage from the one to the other being gradual and only in the latter case relatively abrupt.

In the rhynchodæum of the Schizonemertea and Hoplonemertea the cellular and ciliated layer of the rhynchodæum of the earliest Palæonemertea has been relegated to the background, and the whole has become more a muscular sheath, in which the muscles have, however, a different arrangement in the first and in the second group. The increase in muscularity is in the Schizonemertea more a regular thickening of the fibrous investment, whereas in the Hoplonemertea it is much more massive in one region than in the other. In this way an annular and massive muscular sphincter (as it may be adequately termed) arises in the posterior part of the rhynchodæum (Pl. X. fig. 3, *Sp. Pr.*).

In this muscular sphincter longitudinal and circular fibres are very intimately interwoven, more or less in basket fashion, as indicated in the figure. Moreover, the connection with the general musculature of the head is again brought about by radial bundles, also visible in the figure.

Of the Schizonemertean rhynchodæum no special figure is given; it answers to the short description which was given above, it can be well observed in several figures in M'Intosh's monograph, and, like the rhynchodæum of the other groups, it reaches backwards just as far as the implantation of the proboscis in the musculature of the head. The epithelium of the rhynchodæum is in most cases distinctly ciliated.

The proboscis itself has been the subject of so detailed study and so elaborate description by M'Intosh and other investigators, that I must necessarily restrict myself to those few points on which the Challenger material furnishes certain deviations or additions.

The inner epithelium of the proboscis of *Carinina* shows considerable differences according to the region under observation. In front there are papillæ of a more or less arborescent shape, on which a coating of fairly large cells, with distinct nuclei, and partly vacuolated, is present. Posteriorly the cells are lower and more closely set (Pl. III. figs. 1, 2, *Pe*). This may be partially the result of a different state of contraction, by which the anterior portion is thrown more into folds.

The difference is, on the other hand, further accentuated by the presence of a constriction in the proboscis, which I observed in the longitudinal sections of the only specimen of *Carinina* that had retained its proboscis.

I cannot affirm that this constriction was natural, *i.e.*, that it would also be found in fresh specimens. Since, however, I have formerly described (VII) similar constrictions in the proboscis of *Carinella* and *Valencinia*, there are many *a priori* grounds for also accepting its normal occurrence in *Carinina*. At the same time it more or less coincides with the change in the character of the epithelium just noticed.

The epithelium of the proboscis of certain Schizonemertea was known to be characterised by the presence of nematocysts. In a former publication (VII) I showed that the observation of Max Müller, who first noticed urticating elements in *Cerebratulus urticans*, might be extended to nearly all Schizonemertea, although the size of these elements is generally considerably below that of the type species just mentioned. Müller has given good figures of the shape of the elements in his species; of the others no figures have hitherto been given, and fig. 2 of Pl. XV. is intended to show the situation of packets of urticating elements, batteries, as they might be called, in a transverse section of the anterior part of the proboscis, rather than to furnish particulars concerning the histology of these nematocysts. They are seen to be situated close to the free surface of the cells, and to be of different sizes on the dorsal and on the ventral surface of the proboscis. Three batteries are figured lying free in the lumen of the proboscis; when seen from the side they have the aspect of a brush with close hairs seen in the same way, when seen from above they appear to be more or less circular, and each of the elements composing the battery is then found to be represented by a fine dot instead of by a straight line, as was the case in the side view.

In the spirit specimens of *Cerebratulus* more than these general facts could not be ascertained. I may add that fresh specimens from the Mediterranean showed that each of the elements out of which such a battery is composed has a spindle-shaped form, being more or less pointed at both ends and somewhat bulging in the middle, and that from one of the pointed ends—which in its natural position is directed away from the proboscidian epithelium—the fine urticating thread may be observed to issue. This thread is, in most cases, comparatively short. While in *Cerebratulus urticans* there is hardly any doubt that each urticating element may act independently of the others, it is not improbable that in some species, as the one here described, they remain connected in batteries by whose joint action, when the proboscis is projected, delicate animals may be wounded or paralysed upon extrusion of the proboscis, and may thus fall an easy prey to the proprietor of this formidable weapon.

As to the more detailed histology of this epithelium, I wish to withhold further remarks till I am enabled to publish the observations on the fresh specimens examined at Naples. Similarly the curious and very adhesive epithelium of the foremost portion of the Hoplonemertean proboscis which I have formerly described (IV, V), which was well known to M'Intosh, Graff, and other observers, and which I have again met with in the Challenger Hoplonomertea, cannot be more circumstantially described. Moreover, the stylets in the different Hoplonemertea did not offer any remarkable deviation from the well-known type, and though the transverse sections gave very clear details regarding the arrangement of the muscle-fibres in the muscular bulb, about the epithelium of the glandular duct that conveys the probably venomous secretion of the posterior cavity to the base of the stylet, &c., these are only confirmations of facts already known and need not be recapitulated here. The shape of the stylets was mentioned when the species were described; those of *Drepanophorus*, though not obtained from an actual Challenger specimen, are represented in the woodcut on p. 16.

The muscular walls of the proboscis differ in the various genera, and these differences speak for themselves when we compare figs. 11 and 12 of Pl. II., and figs. 1, 2, and 5 of Pl. III. (*Carinina*), fig. 11 of Pl. VI. (*Eupolia*), fig. 7 of Pl. VIII. (*Pelagonemertes*), fig. 6 of Pl. XII. (*Amphiporus*), and figs. 2 and 3 of Pl. XV. (*Cerebratulus*). These latter show the muscular layers of the proboscis of the Schizonemertea to be a repetition of the muscular layers of their body-wall: a circular layer between two longitudinal ones, the circular layer giving off fibres at diametrically opposite poles to the external membranous sheath (*b*), and moreover, a nervous plexus (*n. pl*), which is also situated between the outer longitudinal muscular coat γ' (that just below the epithelium), and the circular one β'. This nerve-plexus does not go all round, at least it cannot be distinctly made out except throughout one-half of the circumference. It is also traversed by radial fibres, and is again replaced by definite longitudinal stems when we examine a transverse section of the proboscis further back (Pl. XV. fig. 3). These longitudinal stems are characteristic of certain species of *Cerebratulus*, and a plexus, even a far more complete and cylindrical one than the one figured (Pl. XV. fig. 2) for *Cerebratulus macroren*, is characteristic of others. The nerve-stems enter the proboscis at its point of insertion, and spring from the right and left extremity of the ventral brain commissure.

In the posterior regions of the proboscis of *Eupolia*, of *Pelagonemertes*, and of nearly all the other species, the musculature appears to be reduced to a simple longitudinal layer, carrying the epithelium on one side, and being held together by an ensheathing membrane on the other (Pl. VI. fig. 11, and Pl. VIII. fig. 7).

In *Carinina* there is an additional circular layer, and the remarkable fact, which has been already noticed above, of the situation of the nerves still enclosed in the epithelium.

In *Amphiporus*, *Drepanophorus*, and *Pelagonemertes* (anterior portion) the proboscis-wall exhibits the notable complications corresponding with the curious disposition of the nerves in the proboscis, and which was described in sufficient detail by M'Intosh (beaded layer) (XIX, XX), myself (IX), von Kennel (XVI), and Graff (III). To von Kennel the merit is due of having definitely established the nervous significance of the parts in question. The innervation may here be said to represent a plexus with numerous longitudinal thickened portions or stems. The passage of the nerves from the brain into the proboscis can very rarely be well observed, because the proboscis is nearly always extruded and torn off when the animal is killed. I may, however, repeat what was noticed above (p. 85), viz., that in *Amphiporus moseleyi*, more particularly, this doubt has now been dispelled. I can observe in my sections that, instead of two strong nerves innervating the proboscis, as in the Palæonemertea and Schizonemertea, a much larger number of branches leave the brain-ring and enter the proboscis in the region of its attachment. That these may dichotomise and give rise to a larger number of longitudinal stems has been already stated by von Kennel (**XVI**).

This nervous plexus and the longitudinal stems subdivide the longitudinal muscle-layer into an outer and an inner portion, the latter (when the proboscis is everted) being again subdivided into as many longitudinal columns as there are nerve-stems in the proboscis (Pl. XII. fig. 6). Outside and inside of this longitudinal layer there is a circular layer of fibres, outside of the exterior one of these the epithelium.

As to the nerve-stems and the plexus, one specimen of *Amphiporus marioni* showed very distinct cellular accumulations just between each nerve-stem, as if a longitudinal tract of nerve-cells alternated with one of nerve-fibres in the plexus. For the study of this phenomenon fresh specimens will be absolutely necessary. The phenomenon itself has been already noticed, but has not yet been wholly understood, either by von Kennel (**XVI**) or by Graff (**III**).

Just as it has been necessary to curtail our observations on the proboscis because of the detailed information already available concerning this important organ, the proboscidian sheath need not be treated at any length in view of the data that are already furnished by others. It is known to be a closed space surrounding the proboscis, having in the majority of cases its own muscular wall, by the contractions of which the fluid contained in the space is driven against the anterior proboscidian attachment. The muscular sheath thus serves to protrude the proboscis as far as the length of the posterior portion —acting as a retractor-muscle—will allow it.

There can hardly be any doubt, when we take into consideration all the morphological data at our disposal, that the muscles composing the proboscidian sheath gradually took their origin by the increase and modification of pre-existing muscular elements, which belonged to the body-wall and to the body-parenchyma before the proboscis, modified from a tactile organ, as it appears to have primitively been, had yet become evolved, through the growth inwards of the anterior tip of the body, into an aggressive weapon, with stylet or nematocysts, &c. We find the shorter proboscides, and the less significant proboscidian sheaths among the more primitive genera of Nemertea.

Carinella has a short proboscis; the dorsal wall of its sheath is still a component part of the musculature of the body-wall; the ventral wall is thin, and only composed of a few fibres. So it is in *Carinina* (Pl. II. figs. 3, 6, 7, 9, 10; Pl. IV. fig. 6, *Ps*). In *Eupolia* the proboscis is longer, but the sheath is still most insignificant, as may be gathered from the figures (Pl. VI. figs. 9, 10; Pl. VII. fig. 10). It is a space having internally a cellular coating very similar to that of the blood-spaces, the cells of this internal epithelial covering often more or less projecting into the lumen of the sheath. Outside of these cells a few circular fibres are seen to have developed; outside of these there is again the body-parenchyma, with the enclosed blood-lacunæ. There is no doubt that from sections of *Eupolia* alone nobody would be inclined to look upon the cavity of the proboscidian sheath as a very independent cavity, nor is it possible to affirm that the mode of the protrusion of the proboscis, as it was sketched above, is indeed fully developed in *Eupolia* and *Carinella*. There is no doubt that of all Nemertea observed alive, these two were never seen to protrude their proboscis spontaneously, and very often even preserved them in death, when the Hoplonemertea always forcibly expel and even spontaneously detach their proboscis.

There is, on the other hand, no evidence at all which would justify us in regarding the arrangement of these Palæonemertea as secondary or degenerated from a higher differentiated stage. The participation of the body musculature in bringing about the movements of the proboscis in these lower forms renders this more intelligible. Only in the more highly differentiated Schizonemertea, and especially in the Hoplonemertea, the muscular walls of the proboscidian sheath undergo a very rapid increase in bulk, and at the same time become more and more, and in the last-named group even wholly independent of the body musculature. This increase of an organ so eminently mesoblastic as the proboscidian sheath, by gradual addition of new fibres that are even arranged in multiple layers, can thus be traced in all its various stages in the different genera of Nemertea. Salensky would probably not have made his startling hypothesis above alluded to,[1] based on ontogenetical observations of a scission in the proboscidian wall, by which (1) a muscular proboscidian sheath surrounding the proboscis becomes separated from, and independent of, the musculature of the proboscis itself, and (2) an isolated cœlome—the proboscidian cavity—is originated, if he had been as well acquainted with the comparative anatomy of the animals about which he writes as he is with certain details of their ontogeny.

Granting even that the development may, in the species observed by him, follow the paths he has sketched (my own observations on the ontogeny of *Lineus obscurus* (**XIV**) have led to wholly different results on this head), it is not yet permissible to base upon those two ontogenetic observations phylogenetic speculations wholly at variance with all the facts that are furnished by a comparison of the different living genera. The woodcuts given by Salensky, in which a Rhabdocœle proboscis and a Nemertean one are put side by side, look very tempting, but cannot be accepted by me.

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[1] *Archives de Biologie*, vol. v. p. 561; *Zeitschr. f. wiss. Zool.*, Bd. xliii. p. 508.

While fully recognising the importance of Graff's observations for our own interpretation of the Nemertean proboscis, and the genetic relation of this organ to that of the Rhabdocœles (not direct but collateral), I must as emphatically reject the proposed derivation of the proboscidian sheath advocated by Salensky.

We must, indeed, represent to ourselves the gradual evolution of the proboscis as that of an epiblastic organ reaching further and further inwards in successive generations, and strengthened and completed by a mesoblastic musculature; and outside of this the free and independent development out of other mesoblastic elements (primarily belonging to the body-wall) of the sheath. It has been already noticed elsewhere (**XIV**, **XV**), that if these mesoblastic structures could be traced down to amœboid mesoblast cells derived *in loco* out of the subjacent hypoblast, an ontogenetic homology between the tissues constituting the proboscidian sheath and those forming the notochord of Vertebrates would be established.

Returning to the proboscidian sheath of the Schizonemertea, we find it to consist of an outer layer of circular fibres and an inner one of longitudinal (Pl. X. fig. 8, *m Prs*; Pl. XV. fig. 1). The former sometimes, when the sheath is thick and contracted, shows a wavy line. Radial fibres, piercing the two fibrous layers, insert themselves against the inner epithelium, which covers the whole inner surface, looking towards the cavity of the proboscidian sheath. Between this epithelium and the muscular layers there is a broad band of transparent basement tissue (Pl. XV. fig. 1, *b*) following the numerous longitudinal folds of the epithelium just mentioned. These folds disappear when the proboscidian sheath is in distension (Pl. X. fig. 8), a phase that may repeatedly be noticed, even without any extrusion of the proboscis, *e.g.*, as a consequence of complicated coilings of the proboscis inside its sheath. It is easily understood that during such distension the thickness of the subepithelial homogeneous basement layer and of the muscular layers is considerably reduced. A maximum degree of distension is figured on Pl. X. fig. 9, where the epithelium was no longer separately visible, and even the œsophageal epithelium has been flattened out, together with the proboscidian-sheath wall.

As will be seen from Pl. XV. fig. 1, we find outside of the outer circular layer of the sheath the gelatinous body-parenchyma, a thin layer of this even separating the proboscidian sheath from the longitudinal muscular layer a, in the midst of which we notice the true proboscidian-sheath-nerve (*pr.sn*). In addition, I think it is not unimportant to remark, that just below this layer of longitudinal fibres, there are strands of circular fibres which do not apparently belong to the proboscidian sheath, and which, after having been closely applied against the dorsal musculature in the middle line of the back, radiate amongst the parenchyma and the intestinal cæca. It is these fibres (and perhaps in addition to them the circular layer of the sheath itself) which may possibly be looked upon as representative of the layer δ in the Carinellidæ (*cf.* Pl. XI.), and which there takes such a conspicuous part in the dorsal delimitation of the proboscidian sheath.

In many Schizonemertea the proboscidian sheath is thus constituted; in others I find that a phenomenon, which receives its more final expression in certain Hoplonemertea, is not wholly absent—I mean the presence of varicosities, in which the inner space of the sheath is bulged out, without the musculature following. In this way more or less irregular appendages are brought about, generally along the side or the lower corners, having the aspect of accessory reservoirs. In *Cerebratulus* sp. inc. (Pl. XV. fig. 6), from Japan, it seems as if these appendages in the posterior region of the body even surpass in size the sheath itself, which is not a very significant organ in that region of the body, and, moreover, as if these two cæca are filled with a substance of the nature of which the available spirit specimens do not enable me to judge.

I do not wish to discuss here the significance of these facts, not having for the present sufficient material to study them more fully; it is only my purpose to call the attention of future investigators to the phenomenon, which may be so significant for a correct interpretation of the posterior, often semi-rudimentary portion of the proboscidian sheath.

It has been observed that in certain Hoplonemertea the phenomenon just noticed finds a more definite and more regular expression. The first observation of this is due to M'Intosh, who detected in the proboscidian sheath of *Drepanophorus* regular metamerically placed openings, by which the space inside the muscular sheath communicated with other cavities outside of it, that had no muscular walls (XX).

While M'Intosh supposed these accessory cavities to establish a communication between the cavity of the proboscidian sheath and the blood-vascular system, I have since demonstrated (VII) that no such communication exists, but that *Drepanophorus* possesses closed membranous sacs communicating with the proboscidian sheath, and probably serving as reserve spaces for the fluid contents of the proboscidian sheath during the very powerful contractions and distentions which the organ may undergo. In the Challenger specimens the same phenomenon was observed, and I have even ventured to assign all those specimens in which these regular paired appendages of the proboscidian sheath were found to the genus *Drepanophorus*, even when I have not succeeded in determining the armature of the proboscis so characteristic of the genus.

Two sections through the proboscidian sheath of Challenger *Drepanophori* are figured on Pl. X. figs. 4, 5.

The curious arrangement of circular and longitudinal fibres, having the appearance of basket-work in the transverse section, may be understood from these figures, even without any further description.

Between the musculature and the inner epithelial layer there is again a homogeneous membrane, with longitudinal folds indicative of the contracted state in which the sheath here figured was at the moment of its preservation. In neither of the two was the section quite vertical, thus only one of the lateral diverticula is cut, instead of the pair that are opposite each other. The epithelium which coats the internal cavity of the sheath is seen to be continued uninterruptedly in these lateral spaces, whereas the musculature is deficient, and these cæca may thus with propriety be called membranous. There is a decidedly thicker epithelial coating in the lateral sacs of fig. 4 (*Drepanophorus lankesteri*) than in those of fig. 5 (*Drepanophorus serraticollis*). On the other hand, the musculature of the proboscidian sheath of the latter is much more massively developed than that of the former.

One remarkable detail concerning the lateral appendages in *Drepanophorus lankesteri*, is the fact that I found a few of the anterior ones connected by a short longitudinal communicating tube at their distal extremity, this connection being thus parallel to the proboscidian sheath itself. Similar connections were not noted further backwards, nor in any other species of *Drepanophorus*.

While the proboscidian sheath of *Amphiporus marioni* (Pl. X. fig. 1) is built on the same plan as that of *Drepanophorus*, that of *Pelagonemertes* is seen to be much simpler (Pl. VIII. fig. 7). Both are quite freely suspended in the gelatinous tissue, and only connected with the body musculature in the head (Pl. X. fig. 3).

DIGESTIVE APPARATUS.

The digestive canal of the Nemertea cannot be said, from a morphological point of view, to be very complicated.

Communicating with the exterior by a ventral mouth close behind the tip of the head and by a terminal anus, it stretches along the whole length of the body, and only two rather sharply defined regions may be distinguished in it: the œsophagus and the hind gut or intestine proper. Still, even the mouth is not always an independent structure, as it is known to become confluent with the opening through which the proboscis protrudes, *i.e.*, the terminal opening of the rhynchodæum,[1] in at least two genera (*Amphiporus* and *Malacobdella*[2]). In that case this common opening is either terminal or nearly so (Pl. IX. fig. 9), and generally larger than the separate openings in other Hoplonemertea. This feature is clearly not primitive but derived from that condition in which the mouth lies behind the brain-lobes on the ventral surface, as it does in the most primitive

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[1] Rhynchodæum (see p. 8) is the name that may conveniently be given to the passage stretching from the point of insertion of the proboscis in the head to the level of the exterior opening on the surface of the body through which the proboscis is seen to be thrust forth. Its walls are marked *APe* in fig. 5 of Pl. III.; *Rh.* and *Sp. Pr.* in fig. 3, Pl. X.

[2] Salensky has lately (*Biologisches Centralblatt*, 1883, p. 740, and *Archives de Biologie*, vol. v.), in publishing embryological researches on a certain species of Nemertea, imagined that the feature here alluded to was then and there discovered by him for the first time, and necessitated the creation of a new genus (*Monopora*). Although his attention was drawn to the superfluity of this proceeding (**XIV.** p. 41), he still retains the name in a later publication (*Zeitschr. f. wiss. Zool.*, Bd. xliii. p. 481). Still, I am afraid this will not extend its longevity, as all the other anatomical characters most decidedly conform to *Amphiporus*.

Carinellidæ and in the Schizonemertea, in fact in all Nemertea, with the exception of the Hoplonemertea. In the latter the mouth is always in front of the brain; it has thus shifted forwards, the extreme range of this shifting process being reached when the mouth becomes confluent with the opening of the rhynchodæum just recorded.

Another difference between the Hoplonemertea and the two other orders of the class, with respect to the digestive system, is found in the relative position of the œsophagus and hind-gut. While in the two last-named groups these two subdivisions of the intestine pass into each other along a straight line and do not overlap, we see that such an overlapping does occur to a more or less considerable extent in the Hoplonemertea. In a number of transverse sections the hind-gut is cut when the œsophagus is also still present in the section, showing that the latter overlaps the former. Still, I should be inclined to adopt the view that the gradual process by which this came about was not so much a further extension backwards of the œsophagus, as a tendency of the hind-gut to spread out and to reach forwards below the œsophagus. This would seem to be indicated by the fact that in these Hoplonemertea the intestinal cæca, that properly belong to the hind-gut, but that have come to be situated below the œsophagus (Pl. XV. fig. 20), may even reach so far forwards as to become situated close to the brain-lobes, a phenomenon which is never observed in the lower groups, where the whole length of the œsophagus separates the brain-lobes from the hind-gut. Possibly the shifting forwards of the hind-gut and its diverticula may be a phenomenon that runs parallel with (if not due to the same cause as) the disappearance of the lacunar blood-spaces round the œsophagus, and the substitution for them of cylindrical blood-vessels communicating by transverse ducts with the medio-dorsal vessel. The latter arrangement is also typical of the region of the hind-gut in the Schizonemertea, where, however, the circumœsophageal portion of the blood-system is eminently lacunar.

These speculations need not, however, be further insisted upon, and we may now pass to a description of the œsophagus in the Challenger Palæonemertea. Here, again, *Carinina* offers features of interest. In the first place, the exceedingly close application of the œsophageal epithelium against the muscular body-wall below and the thin muscular layer of the proboscidian sheath above is peculiar (Pl. IV. fig. 3). There is no gelatinous connective tissue between the cells and the bundles of circular muscles, not even a basement membrane, and strong powers are wanted to demonstrate any intervening tissue between the bundles themselves, so strongly are they interwoven, and so dense are the muscular layers in this region of the body-wall. Anteriorly there is a sharp bend downwards where the mouth is situated, and in front of this a short bulging out forms a prostomial extension to the œsophagus, which is seen to be cut through in Pl. II. fig. 3.

The cells of the œsophagus, as seen from the section figured, are finely granular, and below those which actually clothe the lumen there are sometimes seen others also with large nuclei (Pl. IV. fig. 7) but less granular and with less distinct boundaries. This figure at the same time reveals the presence of a conspicuous cuticula covering the free surface of the œsophageal cells. It is not streaked, as the figure erroneously indicates, but homogeneous. On it the cilia are implanted.

Concerning the behaviour of the intestine in the posterior body-regions of *Carinina*, nothing can be said, as only anterior fragments were preserved.

In *Eupolia* the œsophagus has become more independent of the body-musculature than in *Carinina*, and in addition to this a separate œsophageal musculature—at least in *Eupolia giardii*—is present (Pl. VI. fig. 9, *oe.m*). In this œsophageal muscular investment an inner longitudinal and an outer circular layer may be distinguished; between the latter and the body-wall there is the gelatinous tissue, only locally interrupted by the lacunar spaces of the vascular system (in which the nephridia [*np*] are suspended), by the dorsal blood-vessel, and by the proboscidian sheath. I mention this, because there is no evidence that this splanchnic musculature has directly evolved out of hypoblastic elements, whereas the evidence that it is enclosed in one continuous stroma with the "somatic" musculature—which in *Carinina* was the only musculature noticed—and not separated from this by a body-cavity, is very complete. It should, moreover, be remarked that where this more prominent intestinal musculature makes its appearance (certain Schizonemertea, *Eupolia giardii*, &c.), the internal circular muscular layer of the body-wall of the Carinellidæ (δ, Pl. XI.) is no longer present in that situation. How far these two may be considered as homologous, must be left undecided as long as we do not possess more complete ontogenetical data. This œsophageal musculature was not noticed in all species of *Eupolia*, and it is certainly curious that it should be present in *Eupolia giardii*, where the body musculature is so exceptionally thick, and might be expected to serve the purpose of compressing and dilating the œsophageal wall quite as efficiently as we must suppose this body musculature to do in the Carinellidæ. M'Intosh, who detected it in *Cerebratulus corrugatus*, suggests (**XXII**) that the œsophageal musculature might assist in a partial protrusion of the œsophagus.

In *Eupolia nipponensis* and *Eupolia australis* this special musculature is absent, and we find, on the contrary, a much more considerable development of the deeper cellular layers of the œsophageal wall (Pl. VII. fig. 12), and a comparatively sharp demarcation between the internal ciliated epithelium (*Je*) and this thick cellular coating (*Jm*), this demarcation even sometimes rising to the importance of an apparent basement membrane (*B*). Between these cells radial fibres, starting from the body musculature, penetrate, and solitary tangential fibres may be observed, but a separate muscular investment of the œsophagus can never be shown to exist. I am not inclined to believe that this difference may be caused by the age or the size of the individual, one of the specimens of *Eupolia nipponensis* being indeed of considerable size and nearly as thick as *Eupolia giardii*.

The same deep cell-layer is met with in the œsophagus of the Schizonemertea (Pl. XIII. fig. 6), and is no doubt of glandular significance. Generally many of the component cells are flask-shaped, the thinner extremity shoving in between the pallisade-shaped inner ciliated epithelium. Moreover, among the Schizonemertea there appear to be differences in the development of muscular tissue in the œsophageal wall, sometimes the circumœsophageal blood-lacuna directly bathing this cellular coating, sometimes (*e.g.*, *Cerebratulus corrugatus*) a special muscular investment of conspicuous development (Pl. XIII. fig. 6, *mto*) being again present together with very strong nerves (*nv*).

The passage from the œsophagus to the sacculated intestine is more or less gradual, in the absence of any forward extension of the latter below the former, as was noticed for the Hoplonemertea.

Macroscopic dissection enables us, nevertheless, to make a clear distinction between these two portions of the gut, although microscopic investigation of transverse sections shows that, histologically speaking, the passage is tolerably gradual. The cell layers of the posterior portion of the intestine have been more than once sufficiently described (see von Kennel (**XVI**), pl. xviii. fig. 11), and it is not always easy to show them to be provided with a nucleus or with cilia. Still I do not hesitate to declare that the whole of the intestine is ciliated, both the central passage and the lateral, generally symmetrical cæca. But this ciliation is often rendered inconspicuous by the fact that the very elongated cells, composing the wall of this portion of the gut, are so overfilled with small spherical globules as not only to render the ciliation invisible, but even to efface the traces of the boundaries between the cells, so that in certain cases—both amongst Schizonemertea and Hoplonemertea—it would seem as if the intestinal wall were replaced by a compact mass of those globules enclosing the intestinal lumen between them. Similar phenomena were observed by Lang (**XVIII**) in the Polyclada, and have been described by other naturalists for other groups of Invertebrates. I will not here enter upon the question of the relation of this phenomenon to the process of intracellular digestion, which on *a priori* grounds may also be presumed to exist in the Nemertea, but will only add that the nuclei of these high and elongated cells may in favourable specimens be discerned, and are deeply situated, far away from the surface.

Whilst strong vertical muscle-fibres pass from the dorsal to the ventral body-wall in a lamellar arrangement, thus constituting what I have termed in a former publication (**V**) the muscular dissepiments, placed alternately between the intestinal cæca, these cæca themselves are destitute of any special musculature. The muscular lamellæ just mentioned, together with the general body musculature, appear to be sufficient to bring about all the contractions in the intestinal wall needed for the progress along this channel of the food swallowed. The intestinal epithelium itself is thus directly implanted upon the gelatinous tissue, and this phenomenon is no less clear in the Schizonemertea than in the Hoplonemertea (Pl. VIII. fig. 3; Pl. IX. figs. 1–6; Pl. XV. figs. 7, 10). Among the latter *Pelagonemertes* is the most striking example of this, because of the preponderance of the gelatinous tissue. It has been already noticed in a preceding paragraph that this jelly appears to be somewhat denser, and that at any rate it more strongly imbibes staining reagents, all round the circumference of the intestinal epithelium where this is implanted upon it.

As to the œsophagus of the Hoplonemertea, I wish to observe that it is less thick and massive than that of *Eupolia* and the Schizonemertea, and more resembles the simple arrangement of *Carinina*. Its wall is generally only one cell-layer thick, and a distinct cuticula, as was noticed in *Carinina*, may also be often observed here. Fig. 1, *Oe*, of Pl. X., representing a section of the œsophagus of *Amphiporus marioni*, gives a very fair representation of it. Outside the œsophageal epithelium there are indicated in this figure a layer of flattened cells which I at first expected to form an outer tunic to the œsophagus. Closer investigation revealed the presence of these cells in all the tissues—they may also be seen in the basement layer *B* of the same figure—and at the same time convinced me that these unicellular bodies are parasitic organisms. They infest all the tissues of their host, and are more abundantly heaped together just outside the œsophageal epithelium, where nutritive substances may be expected to be more plentiful. Curiously enough, they were also noticed in the smaller specimens of *Amphiporus marioni*. Similar cases of specimens of Nemertea infected with unicellular parasites were noticed by me on other occasions. There is another case amongst the Challenger material (see p. 48), but there the parasite is much larger than in *Amphiporus marioni*, and altogether differently constituted. It agrees with the former only in the fact of its presence in all parts of the tissues.

These parasites differ from others which are found in the lumen of the intestine, and which have already been noticed by former observers.

Another view of the Hoplonemertean œsophagus is given (in longitudinal section) in Pl. XV. fig. 20. Here, too, the comparative thinness of the walls is conspicuous, and the connection with the posterior gut portion which stretches forwards under it, is clearly indicated.

In *Pelagonemertes* the last mentioned phenomenon could not be observed. The sections through the mouth and œsophagus were, however, not intact, because of the macroscopic dissection to which the specimen had previously been subjected by M'Intosh.

As to the cæca of the posterior body region little remains to be noticed, but that they are more regularly distributed as we approach the tail, *i.e.*, the region where new cæca are being continually formed. Their metameric and paired arrangement is here more evident than further forwards, where the degree in which they are filled with food particles may be more or less different, and may thereby become the cause of a partial, but not very common, asymmetry.

The innervation of the intestine was for the greater part described in the paragraph treating of the nervous system. It may be remarked here, in addition, that in transverse sections of the foremost portions of the œsophagus it is very easy to detect the considerable nerve-stems, both of the vagus nerve and of the visceral nerves, by which this is brought about, and that in longitudinal sections also (Pl. XIV. fig. 5) the vagus nerve may often be followed uninterruptedly for a very considerable distance backwards, being applied upon the outer surface of the œsophagus, and only gradually dichotomising and sending delicate nerve-fibres amongst the œsophageal epithelium (*cf.* Pl. XVI. fig. 1).

Of the two sources of innervation of the intestine, the one by the nerve-stem directly issuing from the brain-lobes (the so-called vagus nerve) is the most conspicuous, and can be demonstrated in all species from *Carinina* to the more specialised Hoplonemertea without exception. In *Carinina* it is represented in Pl. VI. fig. 1, *Nv*; in this species the visceral nerves (Pl. XVI. fig. 1, *vi.sy;* Pl. XIV. figs. 3, 4, *vi.n*) have not been definitely demonstrated as yet in either of the two available fragments. These latter nerves are more easily detected in larger Schizonemertea, where the thick nerve-plexus is itself so much more conspicuous. *Cerebratulus corrugatus* especially answers this purpose.

In the Hoplonemertea too the vagus is very evident, and already represented on Quatrefages' figures (**XXVIII**); in *Drepanophorus lankesteri* I saw its principal stem running forwards towards the anterior œsophageal portion that passes under the brain.

In this species we find numerous thin nerves, both from the lower brain-lobes and the lateral stems, further participating in the innervation of the œsophagus—a state of things which may be directly compared to the mixed innervation described above for *Cerebratulus corrugatus*.

I cannot as yet supply any definite statement regarding the innervation of the posterior region of the intestine.

NEPHRIDIAL APPARATUS AND BLOOD-VASCULAR SYSTEM.

Our knowledge of the nephridia of the Nemertea is only of a comparatively recent date. Though discovered by Max Schultze as early as 1851 in a *Tetrastemma* (**XXXII**), the observations of this naturalist concerning the Nemertean nephridia were for a long time wholly unjustifiably disregarded, and this general scepticism made me very careful in formulating any definite opinion, when I also discovered in Schizonemertea separate lumina (**IV**), which I could hardly account for in any other way than by regarding them as parts of a nephridial system.

This was afterwards more emphatically done by von Kennel (**XVI**), to whom is due all the credit of having rediscovered the nephridia, and of having described their histological appearance in several different genera. His results were later on confirmed by other authors (**II, III, XI**). I have afterwards observed and described (**XII**) a special modification of the nephridial system in Nemertea, in which an indubitable internal opening is present. This was found by me in the nephridial system of *Carinoma*, and these nephridia thus establish a communication between the internal blood-spaces (archicœlome) and the exterior. In other genera, *Carinella* excepted, similar internal communications were, however, sought for in vain. A very notable and exhaustive contribution to our knowledge of the Nemertean nephridia was then furnished by Oudemans (XXVII), and the Challenger material, which was partly made subservient to that publication, only furnishes a few additional data here worth recording, most of the peculiarities having been already mentioned by Oudemans. I hold it to be one of the principal results arrived at by this author, that he definitely demonstrated the presence in numerous species of Nemertea of a very large number of exterior openings, connected by short transverse branches with the principal and longitudinal canals of the nephridial system, and that, at the same time, he noticed that these transverse canals were paired and opposite, and showed an arrangement which might most assuredly be compared to an incipient stage of metamery in the nephridial system.

This fact is most distinctly borne out by the Schizonemertea. The Palæonemertea (at any rate the Carinellidæ) and Hoplonemertea show an arrangement which presents different features, although, again, certain Hoplonemertea (*Amphiporus lactifloreus*) answer very well to the Schizonemertean type.

A very remarkable form of nephridia is found in *Carinina grata*. The two fragments of this species that form part of the Challenger collection both contain this important structure *in toto*, so that I am able to figure both transverse and longitudinal sections. These figures are brought together on Pl. IV., and will first have to be discussed. Two portions may be distinguished in the nephridia of *Carinina:* in the first place, a glandular canalicular portion in which numerous delicate tubes appear to be closely applied together into a larger lobulate mass, which is situated right and left in the blood-space, not being freely suspended in it, but applied on one side against the muscular layers (figs. 5, 6), and on the other side, offering a free surface towards the cavity of this blood space. Pl. IV. fig. 4 gives a more enlarged view (*Nsp*) of a longitudinal section through this portion of the nephridial apparatus, and, at the same time, enables one to judge of its extension, the whole of this glandular spongy portion having been reached in this section. It is, of course, also present in other sections, but does not stretch either further forwards or backwards.

The furthest blind ends of the anterior cæca of the digestive canal are found to penetrate between the lobes of this glandular mass (*Jc*, fig. 4). These lobes are, moreover, subdivided by bundles of muscle-fibres detached from the inner circular layer (fig. 5), against which the whole apparatus is so closely applied (fig. 4, *Cm*). The cells composing the glandular portion are filled with a granular protoplasm, and have very distinct large nuclei. However much I have looked out in my different sections for a definite opening by which the canalicular system here described might enter into communication with the blood-space (archicœlome) surrounding it, I did not succeed in demonstrating one. Considering that I had found such openings in *Carinoma*, and that Oudemans had afterwards demonstrated them in *Carinella*, I expected they would also be present in *Carinina*. For the present, however, the result of a very attentive search is that they are absent; at least no opening is visible which can be said to prove a similar communication beyond all doubt and by which it might be demonstrated once for all. Questionable points of communication, which might eventually be interpreted as such, I have not allowed to influence my testimony, so that, for the present, I must answer the question in the negative. The case stands in a similar light with respect to the Schizonemertea and Hoplonemertea, as will be seen hereafter.

If this communication with the blood-spaces is thus not demonstrated, that with the cavity of the second part of the nephridial system is subject to a much less degree of doubt; and though I did not actually see the lumen at the point of communication, I did see the communication itself as represented in fig. 4. It is then seen that this second portion is distinguished from the one just mentioned by the presence of a spacious cavity. This cavity, which may be called the nephridial canal, is first found ventrally to the glandular spongy portion (figs. 4–6), but then gradually bends upwards as it passes further backwards along the animal, until it becomes a narrow channel with a very distinct and ciliated epithelium (figs. 1, 2), which passes at a very strongly inclined angle (fig. 1) through the successive muscular layers, then makes a very sharp bend towards the exterior surface, and traversing also the basement membrane and the integument, opens on the exterior. This exterior opening has not been figured, but is found in the sections following upon that which is represented in fig. 1. The two exterior openings of the nephridial system lie on the dorsal surface of the animal, and at the same time mark the point where the nephridial system reaches furthest backwards, the glandular portion of it stretching forwards towards the head. That this nephridial canal may, at all events in its proximal part, be more or less folded, is seen both in figs. 4 and 5, *Nc*, in the latter figure the lumen having an appearance as if it were doubled.

The nephridial system of our second Challenger genus of Palæonemertea, *Eupolia*, is, as was already known from Oudemans' researches, more comparable to that of the Schizonemertea than to that which has just been described in *Carinina*. It offers certain peculiarities which deserve special mention. Here, too, we may distinguish, as we may throughout the whole class of the Nemertea, longitudinal and principal nephridial ducts situated in the blood-spaces or enclosed by the gelatinous tissue (Hoplonemertea), and transverse or deferent ducts placed perpendicular to the foregoing, varying in number and somewhat in size, and bringing about a communication between the ducts before mentioned and the exterior.

Of the aspect and situation of these two portions in a transverse section, a comparison of figs. 9 on Pl. VI. and 3 on Pl. VII. may convince us. Each of them represents about one-half of the thickness of the body-wall of the animal, and though somewhat differently magnified, the position of the nerve-stem and of the layer *cm* may easily guide us how to combine them.

It is then seen that in Pl. VI. fig. 9 the longitudinal trunk, situated in the circumœsophageal blood-space, is not only cut through, but that even more than one nephridial lumen (*nep*) appears in this section, showing that there is a doubling or at least a branching of the principal nephridial duct in this region. Internal openings of this system, funnels or anything comparable to them, were not detected by me in *Eupolia giardii* or any other *Eupolia;* there were, however, very definite bends at right angles, piercing first the inner longitudinal and then the circular muscular layer, next the nervous plexus, and then arriving in the outer layer of longitudinal muscles. In this position the deferent branches of the nephridial system are seen in fig. 5, Pl. VII., which, moreover, reveals the important fact that sometimes more than one of them is found at exactly the same level. I could not make out whether this duplication is in any way related to that of the longitudinal tube; I can hardly conceive it to be so, the increase of the number of deferent vessels being also noticed in other cases, though hardly as a regular phenomenon. In *Eupolia giardii*, too, I find it to be exceptional in this sense, that most of the deferent ducts are single; one section of another species (*Cerebratulus truncatus*) contains the double duct on both sides, making the exceptional phenomenon at the same time symmetrical. The number of deferent ducts observed in the Challenger specimen of *Eupolia giardii* is seven on the right and five on the left side, the latter being opposite to and symmetrically placed with five out of the seven on the right. These numbers, however, only apply to that portion of the trunk behind the head which was transversely cut, and belongs to the same series. I have not followed up the nephridial apparatus to its posterior portion, but we may feel assured, on the authority of Oudemans' researches, that it will on the whole answer to the diagram given on pl. i. fig. 11 of his treatise. One point deserving mention is that the first trace of the nephridial apparatus of this *Eupolia* is visible in about the ninetieth section behind the tip of the snout. When I add that the upper brain-lobes occupy sections 25 to 45, the forward extension of the nephridia can more easily be imagined. Nothing special can be said of the deferent or of the principal ducts but that their epithelium is distinctly one cell thick, nucleated, and unmistakably ciliated. Nor have I any special discoveries to record with respect to the nephridial system of any of the Challenger Schizonemertea, and may refer the reader for certain specific peculiarities, number and disposition of deferent ducts, &c., to the description of the species where I have embodied these details when they did not appear to have any general significance.

I should like, however, to refer a little more fully to the conspicuous development at which the main, longitudinal canal of the nephridia has arrived in a certain species of *Cerebratulus* (*Cerebratulus macroren*), where its walls are unusually massive (Pl.

XIII. figs. 7–9), although, when these walls are distended by the contents, their thickness correspondingly diminishes (Pl. XIII. fig. 8). In this species, moreover, it could be observed that towards the anterior end of this massive nephridial canal it subdivides into smaller branches (Pl. XIII. fig. 9), applied against the wall of the blood lacuna, and nearly escaping observation amongst the epithelial cells of these lacunæ. Here, again, no internal opening could be demonstrated; whereas, at the posterior end, the nephridial canal, making a sharp curve, passes outwards above the nerve-stems. We thus observe differences in the nephridial system of the Schizonemertea, which may be classified under the following heads:—

(*a*) The nephridial canal may be massive and single throughout the greater part of its course, only ramifying anteriorly (*Cerebratulus macroren*, &c).

(*b*) It may be very copiously subdivided, every transverse section showing a considerable number of lumina, the whole thus forming a kind of network, with certain principal longitudinal ducts, and being suspended against the wall of the circumœsophageal blood lacuna (*Eupolia*).

(*c*) The meshes of this network may be situated in the region between the proboscidian sheath and the longitudinal nerve-stems (most *Cerebratuli*), or they may stretch ventrally to these nerve-stems (*Eupolia*).

(*d*) The ducts leading to the exterior may be one on each side, and these generally terminal (posteriorly).

(*e*) There may be two on each side, and they may then communicate with the chief longitudinal canal about its middle.

(*f*) They may be more numerous, often in various phases of distension, and arranged more or less metamerically. The histological characters are fairly uniform, the lumen is never excavated in a row of cells as is the case in so many Platyelminthes, in the Discophora, &c., but is always bounded by a certain number of cells in every section. Each of these cells has a large and distinct nucleus; its protoplasm is granular, and the free surface, which is turned towards the lumen, is ciliated.

We have now to examine the nephridia of the Challenger Hoplonemertea. In Oudemans' paper several points concerning them have been already noticed; other details referring to the situation and the number of the deferent ducts were mentioned above when the species were described.

Hence it may here be sufficient to call attention to the fact, made specially palpable by certain of the Challenger preparations, that whereas the nephridia of the Hoplonemertea are no longer suspended in blood lacunæ, but wholly surrounded by the gelatinous tissue, they are at the same time much more intricately coiled and ramified, as can be very easily seen from a comparison of fig. 1 (*Nep*), Pl. X., with figs. 7, 9, Pl. XIII. This involves, however, no important change in the histology; what we have noticed under this head in the Schizonemertea holds good for the Hoplonemertea as well.

Even less remains to be said when we consider the blood-spaces of the Challenger Nemertea, be they the closed longitudinal and the metameric transverse vessels of the Hoplonemertea and of the posterior body-region of the Schizonemertea, or the circumœsophageal and circumrhynchodæal lacunæ of the latter, or the two spacious lateral longitudinal cavities of *Carinina*.

All these points have been dwelt upon at length by Oudemans (**XXVII**), and the Challenger material furnishes a general confirmation of his results. Doubt cannot be any longer entertained that these spaces are all clothed by an epithelium,—at any rate by a special and continuous cellular coating, either applied against the muscular tissue when this surrounds (Pl. IV. figs. 5, 6; Pl. XIII. fig. 6; Pl. XIV. fig. 4), or traverses (Pl. VII. fig. 10) the cavities or against the gelatinous tissue, when it is in this that the vessel takes its course (Pl. X. figs. 1, 8). In the latter case the structure of the vessel is still more complicated, so that, as described by Oudemans, there is constantly a tubular, denser layer of the homogeneous tissue just outside the inner epithelial coating; and outside this tubular layer, which might be termed the basement layer of the vessel, we find a second layer of generally more spherical cells, amongst which a layer of fibres, specially belonging to the blood-vessel, may be seen to make its appearance (Pl. XV. fig. 1, *dv*).

This same description holds good for the longitudinal vessel, as far as it takes its course inside the proboscidian sheath (Pl. X. fig. 8). The gradual narrowing of the circumœsophageal lacunar space into the two ventral vessels shows the passage of the epithelium of the one into that of the other very clearly.

The difference in the distance along which the medio-dorsal vessel is enclosed in the proboscidian sheath was mentioned and figured by Oudemans (**XXVII**) for different species; my own observations on the Challenger specimens fit into the same general outlines; a few additional data concerning these points are contained in the systematic description of the species.

GENERATIVE ORGANS.

Certain not unimportant additions to our knowledge of the generative organs of the Nemertea are due to the Challenger specimens. Among these facts I wish successively to record:

(*a*) The irregular distribution in certain species of very numerous generative sacs enclosed in the gelatinous tissue, and having each its separate external opening, which are consequently neither paired nor metameric.

(*b*) The comparatively late period at which the definite external opening is formed, although long before that time the sac is characterised by a pointed projection reaching between the muscular tissue and foreshadowing the definite openings, dehiscence of the body-wall being certainly not the normal way of exit of the generative products.

As to the first point, it has been hitherto the current idea that in the Nemertea the generative sacs, alternating with the intestinal cæca, are paired and more or less metameric. This is no doubt the case in the very large majority, and relieves us from the duty of further describing the position of the generative sacs in *Eupolia*, the Schizonemertea and most Hoplonemertea. In other Hoplonemertea, however, we find a multiplicity of generative sacs in one transverse section (Pl. IX. fig. 4) which cannot possibly be made to answer to the type just alluded to, and this irregularity reaches its extreme expression in *Amphiporus moseleyi*. The specimens of this species are literally full of sacs, which I was able to notice in their first stages, as well as in their later development and ripest stages. In each transverse section (Pl. IX. fig. 4) a great number of them may be seen; in horizontal sections (Pl. IX. fig. 7) the same irregular multiplicity is met with. Externally I did not notice the openings, but it must be remarked that only in very ripe specimens are these distinctly present.

Now this aberrant distribution is not wholly limited to *Amphiporus moseleyi*. There are even reasons for considering it as an arrangement which has been retained in this species, but which was common in the more primitive ancestral species of both the Hoplonemertea and Schizonemertea. At least I find it in a similar condition in *Carinella annulata*, with this difference, (1) that it is here only in the dorsal half, above the intestine, that the generative products are found ; and (2) that the external openings are generally very distinctly visible as numerous irregular whitish dots on the dorsal surface of the animal, in the dark coloured space between the dorsal median white line and two successive transverse ones.

Whether in *Carinina* similar conditions exist could not be verified, because the preserved fragments contain no generative products. At any rate the fact is fully established for one of the most primitive genera of Palæonemertea, and this may justify our insisting upon its having an archaic significance.

With the exception of *Amphiporus moseleyi*, *Drepanophorus lankesteri* is perhaps the only Hoplonemertean in which still another trace of it is preserved, at least if we may consider the fact that in this species (Pl. IX. fig. 1) two ventral generative sacs are present on each side, as a reduced phase of the phenomenon, which we have found represented in *Amphiporus moseleyi*, instead of looking upon it as a secondary duplication of primarily simple generative cæca. For myself, I should feel inclined to take the first view as rather the more probable.

The other Hoplonemertea have not this peculiarity. The generative sacs are paired and metameric, and if in ripe specimens two of them are cut in one section (Pi. IX. fig. 3) it is generally an indication that the section was not perpendicular. There is then also found an adequate distance between the external pores.

This same figure clearly illustrates the fact that the generative products (in this instance ova) may attain a considerable development and closely approach the ripe condition before the generative sac itself communicates by a pore with the exterior, as indicated in the second of the two propositions above enumerated. At the same time we find the spot where the pore will appear indicated by a pointed projection of the sac between the muscles, and it is a fact very worthy of notice that the more we approach this preformed outward duct, the less ripe are the ova (Pl. XV. fig. 14). The same fact is noticed in many other Nemertea; *Pelagonemertes* even shows traces of it (Pl. VIII. fig, 8, *ov.*) In *Carinella* I found it persisting even after the definite pore is established, and the most plausible explanation appears to me to be this, that the deeper inwards the developing generative products are situated, the more they are surrounded by the gelatinous tissue, and the better their conditions of nutrition must be; whereas those which are observed close to the duct, piercing the muscles, will only gradually increase in size, when in their turn similar favourable conditions are offered to them.

The fact of the occurrence of definite preformed ducts without pores was observed by me in *Amphiporus moseleyi*, *Amphiporus marioni*, *Drepanophorus lankesteri*, and *Drepanophorus serraticollis*, and of several of these I also had ripe specimens, in which the fact could be determined that it is, indeed, in the places where these pointed projections are found that the pores afterwards appear (Pl. IX. figs. 5, 6).

In this place I may mention that according to embryological observations (**XIV**) the generative sacs are primitively in connection, at least in the species investigated, with the epiblast by means of a strand of tissue which is not indicative of the ultimate duct. These strands, however, are situated on the other side of the nerve-stem, and thus are in no way identical with the projections which were here described and discussed as preceding the definite generative pores.

The duct which pierces the muscles to afford a passage to the generative products is generally shortened as maturity advances, through the distension of the body by the ripening of ova or spermatozoa, and the consequent decrease in thickness of the muscular body-wall. Still, in *Cerebratulus macroren* this duct presented an uncommon feature, which must here be mentioned, and which is figured on Pl. XV. fig. 19. After having pierced the circular muscular layer β, it distends in the layer γ to a second sac-like expansion, which in its turn communicates with the exterior by a small opening. This was not a local disturbance, but was met with in very numerous generative ducts, both on the right and left sides of the animal.

In *Eupolia* and Schizonemertea the ripening sacs, developing in pairs between each successive pair of intestinal cæca, are often wedge-shaped, with the sharp edge turned outwards, and the broad end between the two intestinal cæca, where these emerge from the principal longitudinal cavity of the intestine (see woodcut fig. 6, p. 120). And, in addition to this, another fact is very marked in *Eupolia giardii*, viz., that dorsally and ventrally the generative cæca become lobulated or arborescent, sending out short lobes of indented and irregular shape.

It would, however, lead us too far, and hardly offer any additional interest, to discuss the changes in shape which the developing generative sac may undergo ; accordingly we will now consider a few diverging peculiarities of the generative products themselves, which I was able to observe in the Challenger Nemertea. That they are developed from the epithelium of the generative sacs has long been known ; this is figured on Pl. XV. fig. 14, in a Hoplonemertean. It was particularly evident and very distinctly visible in *Cerebratulus longifissus*, where it was at the same time also demonstrable that there is a very sudden decrease in ripeness of the generative products close to the tail-end, where growth in length of the animal is going on, and where new generative sacs are being formed between the intestinal cæca. In this region all the most different stages of ripeness of the ova may be studied side by side in the same longitudinal section. The ova of *Amphiporus marioni* (Pl. XV. fig. 15) are characterised by the presence, in addition to the nucleus, of a round or reniform body, which is stained dark red by picrocarmine, and but for this offers a certain analogy to the oil-drop in fish eggs, being also more refractive than the nucleus, though not quite so highly as the latter. This paranucleus was already observed in the youngest eggs (Pl. XV. fig. 15, *a*) ; at that time its relative size, when compared to that of the whole egg, was much more considerable. A second smaller specimen of *Amphiporus marioni* was distinguished by the same peculiarity, which may thus in certain cases help to identify the species, as I did not find the same feature in any other species of Hoplonemertea.

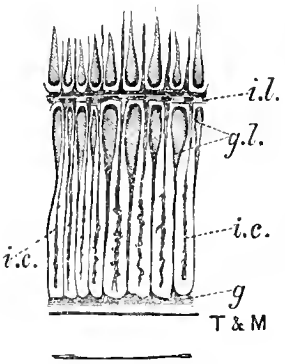

Fig. 6.—Portion of a horizontal section of a *Cerebratulus*. *i.l.* the digestive tract, *i.c.*, its lateral cæca ; *g.l.*, the genital glands ; *g*, gelatinous tissue ; T & M., integument and musculature.

Of the eggs of *Pelagonemertes* it has already been recorded that they are distinguished by an investment of follicle cells (Pl. VIII. fig. 11) ; the development of this could also be traced downwards to early stages, which were present in the same specimen (fig. 10) side by side with the riper stages.

In the Schizonemertea two facts deserve mention, although their significance cannot well be discussed as long as fresh specimens are not available. The one is the presence round the ripe eggs in *Cerebratulus*, sp. inc. (Pl. XV. fig. 18), and *Drepanophorus serraticollis* (Pl. XV. fig. 17) of a hyaline, apparently mucous layer, which surrounds each egg separately, and which is pressed into a polygonal shape when many ripe eggs are enclosed together in the same sac. The layer is comparatively thick.

The second fact was observed in *Cerebratulus parkeri*, where the peripheral protoplasm was much more darkly stained and more coarsely granular, all the eggs having thus the aspect as figured on Pl. XV. fig. 16.

As to the spermatogenesis I have no new observations to record, spirit specimens alone rarely presenting favourable material for such researches. These phenomena have, moreover, been recently fully studied by Sabatier (XXVIII*a*).

Hermaphrodite specimens were not encountered by me in the Challenger collection.

GENERAL CONSIDERATIONS.

In venturing at the close of this Report on the Nemertea, collected by H.M.S. Challenger, to leave the region of demonstrated facts and actual observations, and to enter upon that of speculation and suggestion, I gladly avail myself of the permission for so doing granted to me by the editor, Mr. John Murray. I thought it necessary to ask for that permission, because general speculations on the ancestry of the Chordata hardly appeared to me to fit into the framework of these Reports. My desire in this case to deviate from a rule which I held to be salutary, was due to the fact that of late these speculations have been conducted along very varying channels, an entirely new one having only very lately been opened by Bateson's important series of papers on *Balanoglossus.* An attempt to give more depth to one of these channels, and thus to lead into it the attention of a greater number of my fellow-workers, especially commended itself to me, since it was my conviction that the lines laid down by myself in former publications derived considerable support from the Challenger material, and were thus entitled to a renewed and full consideration.

I would formulate the proposition, to the further development of which this chapter is to be devoted, as follows :—

More than any other class of invertebrate animals, the Nemertea have preserved in their organisation traces of such features as must have been characteristic of those animal forms, by which a transition has been gradually brought about from the archicœlous Diploblastic (Cœlenterate) type to those enterocœlous Triploblastica, that have afterwards developed into the Chordata (Urochorda, Hemichorda, Cephalochorda, and Vertebrata).

It will be seen that this statement excludes the idea of any direct ancestral relations between Nemertea and Chordata. If any such relation were proposed, it might with good reason be asked—considering the very extensive variation which is met with amongst Nemertea—which species or which genus was more particularly pointed to. The question in itself condemns the proposition which leads to it.

It will, moreover, be seen that this statement accepts the outcome of Bateson's researches and speculations, in so far as the points of agreement between *Balanoglossus* and *Amphioxus* are fully recognised. A provisional link between these two, and an arrangement of *Balanoglossus* amongst the Chordata, appears to be quite as justifiable as the elevation of the Urochorda to their new dignity in zoological classification.

There is, however, a great difference between looking at *Balanoglossus* as a low type amongst the Chordata (in which I fully agree with Bateson) and rejecting the significance of the Nemertean type as one of transition in the way above indicated.

There is no doubt that the Nemertea represent a more primitive phase than the Enteropneusta (Hemichorda). They have no enterocœle, and they have no gill-slits; but their nervous system shows certain unexpected analogies with that of the higher Chordata of more intrinsic value than those that obtain between *Balanoglossus* and the Chordata in general. Also for the important question, which is so vital in any consideration of the ancestry of the Vertebrates, viz., the origin of metameric segmentation, it appears to me that the Nemertea offer points very worthy of consideration. The question of the proboscis and its sheath, as comparable to hypophysis and notochord, was fully treated by me in another paper, and will here only be very briefly touched upon. In my opinion, this comparison is all the more forced upon us, now that in other respects (nervous system, &c.) new evidence of genetic relationship is here brought forward.

The first point I wish to consider is that of metameric segmentation. It has been specially treated of late years by various authors of renown, with whom I do not wish to enter at this moment into any lengthy controversy, but will briefly state what may be gathered for the theory in general, from a careful consideration of the incipient metamery of the Nemertea.

If we start from a more or less radiate ancestor of the earliest diploblastic type, in which neither a radial nor a serial repetition of organs or organ systems has yet come about, and which may indifferently be considered to resemble either a more flattened *Trichoplax* or a more spherical *gastrula*, we may assume that in the course of the development of other internal organs (towards the formation of which the secondary accumulation of cells between the two primary layers often so largely contributes) the radial symmetry may either be further accentuated or may be replaced by a tendency towards bilateral symmetry. In the latter case we are inclined to ascribe the first impulse towards this bilateral symmetry to a preference, which slowly establishes itself in the animal mechanism, for moving in one direction rather than in any other, *i.e.*, for generally stretching forward, when moving about, one particular portion of the body.

One impulse of this sort will suffice to lead us to understand, or rather to deduce, a very considerable number of consequences, which cannot fail to make their appearance under the influence of natural selection acting upon the organisms that have inherited this tendency in different degrees. Thus we may understand the narrowing and lengthening of an animal that moves in one direction in preference to any other; and similarly the development in the nervous system of a centralisation not far away from the anterior extremity.

All this has already been stated by Balfour in clearer terms in his Comparative Embryology (vol. ii. pp. 308, 311), where he describes the gradual steps by which a radiate medusa-like animal may have passed into a bilateral worm-like form, with two longitudinal nerve-stems, which are regarded by Balfour as the stretched nerve-ring of the Medusa.

I fully endorse these views; only, with respect to the nervous system, I hold it to be safer to leave out of comparison the already specialised nerve-ring of the Medusa, and rather to go back to a Cœlenterate nervous system as primitive as that of the *Actinia*, where the plexus, both of the epiblast and the hypoblast, with an increase in density in the region of the mouth and the tentacles, may be said to be the fair representative of one of the lowest starting points. In this the plexiform arrangement predominates.

Now we find in all the lower invertebrates various though distinct nerve tracts that are being specialised in this plexiform nerve-tissue according to the modes of motion of the animal, and according to the general shape of the body.

Thus in the Medusæ, which move about in the water by annular contractions of the lower portion of the bell-shaped body, one of the nerve-rings already alluded to was demonstrated by the Hertwigs to innervate the musculature by which this is brought about.

In the Ctenophora the nerve-system is less satisfactorily known, but still Lang does not hesitate to bring them into genetic relationship with the Polyclada (XVIII). Among the latter, *Gunda*, with its two longitudinal lateral stems, may be looked upon as an extreme term in this series.

Another series may indeed be supposed to have derived longitudinal stems from a ring which became extended to form lateral cords, as the animal passed from the radial to the bilateral symmetry, in the way suggested by Balfour. Still, even in this case, a nerve-plexus may be expected to be co-existent with or to have preceded the nerve-ring. The longitudinal stems originating from the anterior thickenings of the plexus that innervate the sense organs and the tip of the head (specially sensitive in connection with the forwardly-directed movements of the body), would all the more probably be preserved and increase in development, as during this forward movement they form a right and a left centre for the reception of outward stimuli. In the same way those of the radially-arranged stems of the Polyclada that are parallel to the longitudinal body-axis, and mark out right and left, are more strongly developed than the others, presumably on account of their importance in connection with the well-directed movements of the body in response to external agents.

In the ancestral Mollusca, I think we may assume with great probability the presence of four longitudinal stems—two latero-dorsal, and two latero-ventral ones; in the ancestral forms of Annelids and Arthropods two, which have gradually coalesced ventrally, as was first suggested by Gegenbaur. Again, in Nematodes differently situated longitudinal stems in what was originally a uniform plexus are preserved; whereas, in ancestral Nemertea, two lateral longitudinal trunks in the plexus were undoubtedly characteristic features.

That one medio-dorsal stem in this plexus, in which all the impressions made by outward agencies on both halves of the body might be concentrated, and from whence the corresponding movements might be regulated, will more fully answer the purpose than two lateral stems, however they may be united by an intervening plexus, is *a priori* probable, and would explain the first impulse towards the formation of such a longitudinal concentration in the uniform plexus.

And when once such a dorso-median stem is present, in addition to two lateral ones, a struggle for supremacy, presided over by natural selection, may lead to a diminution of the lateral stems, and to an increase of the dorso-median one.

This, in my opinion, as will be more fully developed below, was the case in the ancestors of the Chordata, traces of this struggle and of the competing structural elements being duly preserved.

If we suppose the bilateral symmetry to be established in one of the lower representatives of the Metazoa, and the type to go on increasing in length in the course of generations; then this increase, indeed, exposes it to very different, and perhaps more numerous dangers and enemies than would threaten it were the same bulk concentrated in a spherical or radial circumference. And if, even in the latter case, injuries to the specimen might prove fatal were it not provided with strong powers of regeneration (*cf.* Star-fishes, Ophiurids, Crinoids, &c.), still it needs no comment that, when bilateral symmetry and increase in length so considerably enlarges the surface which is open to attacks, and so enormously facilitates the rupture of the specimen, or the severing of parts by rapacious enemies preying upon it, similar regenerative powers are none the less required to insure the persistence of the type.

These dangers, continually threatening the existence of the specimens, and thus injurious to the species, counteracted as they are by regenerative processes (power of reproduction of lost parts), *I hold to be at the base of all those cases of metamery in the animal kingdom which do not fall under the head of strobilation,* the latter being comparatively rare with respect to the former. Incipient metamery, once established by this cause, may further differentiate in the most diverse directions (heteronomous segmentation, &c.), even after the absolute cessation of the causes that in the first instance have provoked it.

The explanation has, moreover, the advantage of being applicable to radial as well as to serial metamery.

These propositions must now be more fully developed. The power of reproduction of lost parts comes, without doubt, under the general laws of formation and growth. We find it even in the lowest Protozoa. If the material which heredity has accumulated, either in such a unicellular being or in the egg of a Metazoon, and out of which the elements of the different organ systems will gradually develop, is hereditarily so disposed that a compensation for the loss of important parts is facilitated, this will, of course, constitute an advantage. Such a compensation may, *e.g.*, be obtained where the generative products are developed in very many separate centra, and not in one closed sac. Injury to the latter will, *ceteris paribus*, be more fatal than an equivalent injury destroying one or more of the former. The same holds good for diffused instead of concentrated nervous centra, for the case of liver saccules to the intestine, instead of one compact liver, for numerous apertures and deferent ducts to the nephridial system instead of one, &c. And all this is still more evident when we have before us a long, bilaterally symmetrical animal, which is easily snapped in two. In this case it must be of pre-eminent importance, that the remaining halves, which may in their turn be severed by the same cause into smaller parts, possess sufficient power of reproduction to repair the damage. Now, it cannot be doubted that an equal distribution of the important components of the organism (nervous centra, generative organs, nephridia, intestinal appendages, &c.) throughout the whole length of the animal meets this requirement. Any severed portion will then be provided with these more important parts, and will be more or less adapted for a separate and individual existence.

The formation of a new mouth and of new brain-lobes in a fragment of this description remains, of course, quite as wonderful and inexplicable as before, but still we cannot fail to see that such an arrangement as here indicated must somehow be beneficial to the species, and that we need not stop short with Bateson,[1] when he says that "the repetition of various structures is one of the chief factors in the composition of animal forms. . . . . The reason for their appearance is as yet unknown, and the laws that control and modify them are utterly obscured." Obscurity is not exchanged for broad daylight, but something is gained when we can see that a growth of the principal organ-systems in separate and more or less independent batches, which in an elongated and bilaterally symmetrical animal insensibly passes into the phenomenon of incipient metamery, may be of the highest value for the persistence of the species.

Now this is actually the way in which we find the important organ-systems distributed in the lower Nemertea. And out of this more irregular distribution a gradual metamery, in some incipient, in others more complete, is seen to evolve within the boundaries of the class. Even the nephridial system, in the primitive forms provided with only one opening to the exterior, participates in this tendency towards metamery, and acquires a greater number of apertures, serially arranged in pairs, thereby also tending towards a diminution of damage when artificial division into two takes place in the nephridial region. The metamery, the regular and serial repetition of parts, is thus seen to be of great importance in aiding towards repair after damage to a lengthened bilateral form, in the same way as the radial repetition of parts facilitates repair in the Echinodermata. In both cases the

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[1] Bateson, The Ancestry of the Chordata, *Quart. Journ. Micr. Sci.*, vol. xxvi. pp. 545, 546, 1886.

destruction is only partial, the other homonodynamic portions temporarily ministering, thanks to their more independent relation to the injured region.

When the faculty of repair of damage, occasioned by the severing of the animal into two or more portions, has in the course of generations become more and more complete, it can be readily understood that it becomes at the same time a defensive instead of being only a curative process. An animal that at the approach of danger can separate in two or more parts, each of them capable of reproducing an entire new animal, evades this danger very effectively by doing so; whereas another that is attacked in the same way and does not possess this faculty, is laid hold of, shaken about, and wholly or partly swallowed. So in the Nemertea there is indeed a very strong faculty of spontaneous division combined with the faculty of repair[1]; and anybody who has observed a fresh and living *Cerebratulus,* with its extremely delicate sense of touch, commence to rupture into two, in preference at the spot where it was grasped with the forceps, cannot fail to see in this a defensive action.

This mode of self-defence may in quite another respect be useful to the species, because at the same time it serves for propagation. Thus we see that the passage of this defensive process to that of reproduction by fission is so gradual, that it would be impossible to decide in every case what name should properly be applied to it. It cannot well be denied that in all probability ours is only a special case, in which the power of reproducing the species by a process of fission, reaching down as far as the unicellular ancestors, has come to be regulated by other motor forces than growth and—if it may not be called voluntary fission—still may be regarded as sudden and spontaneous fission, brought about by external influences, of a threatening nature to the further existence of the specimen. This regulation is no doubt a consequence of selection. Schizogony having once been established, it must have been further beneficial to the species, on the grounds that were developed above, that the internal organs should be present in multiple numbers, and this having once come about it is easy to understand, that a regular, rigorously metamerous arrangement of this multiple material, still more fully answers the same purpose, and is gradually evolved under the influence of selection.

Thus we may be said to be able to follow the appearance of metamery in a bilateral animal, along all the gradual steps by which it is evolved, and many of these steps have remained fixed and permanent in different Nemertean genera.

The last system that will participate in this metamery is the muscular system, and a rash conclusion—such as is not rare in these days of ontogenetic fetichism—might lead to the rejection of the views concerning metamery here developed, on the consideration that it is exactly the metamery of the muscular system which appears first of all in the

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[1] Both M'Intosh and Barrois have observed and described very peculiar cases of repair in Nemertea, where the head, brain, side-organs, &c., were reproduced on a headless trunk-piece. These experiments are well worthy of careful repetition. It might be that only those fragments in which a portion of the œsophagus was retained were capable of repair of the head.

ontogenetic development of Vertebrates. I will not circumstantially refute this argument, but will only remark that in *Polygordius* and other Chætopods, which are representatives of a group of animals in which segmentation reaches such a very high degree of perfection, the longitudinal muscular layer of the body-wall is as yet continuous in the adult, and not divided into metameric sections, as it is in certain Arthropods and in Vertebrates. Now let us consider contractions of the inner muscular layer **a** of the Nemertea, the only layer that is common to all of them, from *Carinella* to *Cerebratulus* and from *Cephalothrix* to *Pelagonemertes*. This layer also corresponds with the longitudinal muscular layer just alluded to of other lower worms, such as *Polygordius*, and, as was noticed in our paragraph on the muscular system (*cf.* p. 72), its contraction is sometimes very distinct in favourable sections.

We then see the contraction marked out as so many successive blocks of contracted, thickened fibres, separated by intervening parts of non-contracted fibrous tissue (Pl. XV. figs. 9, 10). The sections demonstrate that the phenomenon persists throughout the whole breadth of the animal, *i.e.*, that successive rings of contractile tissue alternate with intervening rings in which no contraction is observed. This phenomenon is thus in a certain degree comparable to an arrangement in distinct myomeres.

It is not unimportant that it was especially noticed in the fundamental muscular layer, and it may at the same time be remarked that it appears, from what I have as yet been able to observe myself, that the number of these rings in a given length of the animal, is the same, or a multiple of the number of intestinal cæca and transverse nerve-tracts in the plexus; in other words, that the incipient metamery of the internal organs is in a definite relation to these phenomena—which might also deserve the name of incipient metamery—in the muscular layers.

For the present the fact is, however, not yet definitely demonstrated that these successive blocks are indeed present as such in the living animal. The possibility is still open that they may be waves of contraction which have been fixed at the moment of the immersion of the animal in the preserving fluid. For this reason I will not lay any undue weight on this observation.

The ideas concerning the origin of metamery here expressed, and advocated for several years in my university lectures, differ from those of Lang (XVIII) and Sedgwick,[1] in so far as they do not recognise the primary importance of the so-called cœlomic sacs—the paired archenteric diverticula of *Amphioxus*—for the solution of this question.

The question of the Vertebrate cœlome, so full of obscurities and difficulties, is purposely left out of consideration here, where the relation to archicœlous ancestral forms is discussed, and where an attempt is made to show that it is indeed probable that the impulse towards the establishment of metamery is due to forces for which the

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[1] A. Sedgwick, On the Origin of Metameric Segmentation, *Quart. Journ. Micr. Sci.*, vol. xxiv. p. 43, 1884.

archenteron was not the only, nor perhaps the most important part of the organism to act upon.

Still more different are they from those advocated by Perrier[1] and Cattaneo,[2] who have adhered to and extended the idea already held by others, but by them most actively defended, "that the metamery of Arthropods, Vertebrates, and a great many Vermes, has originated out of the multiplication by transverse fission of very simple primitive worms which were not metamerous. The products of this transverse fission remaining connected together have then formed a chain of individuals, or a linear colony; later on the unity of the chain has become more definitely established, the single individuals at the same time becoming different both in form and in function, and the foremost individual thus becoming *the head* of the series. Each segment (metamere) thus represents a reduced individual; a metameric (segmented) animal is the result of the more or less complete fusion of single individuals into an individual of higher order."

Emery, from whose paper[3] I have translated the foregoing sentence, has very successfully combated these propositions. This author, however, adheres to Lang's views in ascribing to the archenteric pouches, the "gemmation" as Emery calls it (*loc. cit.*, p. 18) of the intestine, the most important and initial significance for the first origin of metamery, "the sexual glands and excretory canals being in relation to the intestinal diverticula," and following the lead. I have above explained why I cannot adhere to this argumentation, which brings the cœlome and the sacculated intestine too strongly into the foreground, and why I rather suppose incipient metamery to have been antecedent to either of these (*e.g.*, *Carinella*). On the other hand, many views contained in Emery's important paper coincide with my own. Thus he writes (*loc. cit.*, p. 11), speaking of that interesting marine Triclade, *Gunda segmentata* :—

"The metamery of *Gunda* is thus manifestly the consequence not of the 'symbiotic' fusion of a colony of equivalent 'parts' (meridi), but of the 'autobiotic' differentiation and perfectioning of one 'part' (meride);" and further on (p. 15) :—"When I consider the facility with which certain worms break into one or more pieces even spontaneously, it appears to me that this capacity for rupture may well have been the origin of the reproductive purpose of transverse scission in similar elongated organisms. The rupture, in the first instance accidental, could have contributed to the more rapid multiplication of the organism, being followed by the regeneration of the parts that were deficient in the separate fragments. This process of rupture might further have been so perfected that the spot best adapted for rupture, with a view to the best condition of the fragments, was prepared in advance. In the more perfect evolutional phases of the process, which are at the same time those that have till now been more carefully investigated, the new head is formed anteriorly to the rupture, or at least its essential parts are pre-established."

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[1] E. Perrier, Les colonies animales, Paris, 1881.

[2] G. Cattaneo, Le colonie lineari e la morfologia dei Molluschi, Milano, 1883.

[3] C. Emery, Colonie lineare e metameria, Napoli, 1883.

My own views emphasise the presence of a peculiar process of development of the internal organs, running parallel to this predisposition for rupture in a particular spot—the spot which will correspond to the outwardly visible demarcation between the future segments. They thus go one step further—and, in my opinion, a very essential step—in the attempt to explain the origin of metamery in the lower Platyelminthes, these bilateral descendants of radiate Cœlenterata, and at the same time predecessors of both Chordata and Appendiculata.[1]

This view of the origin of metamery also affords an explanation for the very different degrees in which we find metamery or segmentation expressed in the different divisions of the animal kingdom. The incipient metamery which we have traced (and which we have pictured to ourselves as arising through natural selection amongst those forms, which, while developing in length, find metamery to be a protective peculiarity) immediately creates, by the fact of its existence, new and variable material for selection, again to be acted upon. And whilst metamery develops in one direction in one line of descendants, the other line brings to the foreground a different set of advantageous combinations, each of them again the stock of new and varied forms. In other words, metamery once established in its most primitive form, and intimately connected with spontaneous fission under the influence of external agents, has been of very great moment in the bringing about of new and endless variations of animal life. And it is irrational, when we have before us, say one of the lowest Vertebrata, in which nobody will deny the presence of distinct metameric segmentation, to conclude that this metamery must necessarily be in many respects reduced, and that in the ancestral forms it must have been far more complete, must have stretched forwards along the whole of the head, must have been more forcibly expressed than it is now—in all the cephalic nerves, in the nephridia, the gill-slits, &c.;—all this on the presumption of the existence of an ancestor so completely and exemplarily segmental as to throw no light on the origin of segmentation and metamery, unless by the aid of Perrier's and Cattaneo's exaggerations. Such conclusions must, however, necessarily be made by those who follow Dohrn's and Semper's lead concerning the phylogeny of the Chordata.

Bateson, in taking *Balanoglossus* as his starting-point, finds the acknowledged points of resemblance in the metamerous gill-slits, &c., and adds to them important data concerning the metamerous cœlomic diverticula. Still, for a general view on the origin of metamery, *Balanoglossus* offers no points that we do not find more strongly represented and more forcibly expressed in the Nemertea. It certainly deserves mention that long

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[1] Gegenbaur, in his Grundriss der Vergleichenden Anatomie (1878), hints at similar explanations to those advocated by Emery and myself, when he says (p. 64):—"Die Metamerie . . . . lässt Zustande des Beginnes und der nicht ausgefuhrten Beendigung mannichfach erkennen . . . . In dem Maasse als ein Metamer die Abhangigkeit vom Gesammtorganismus durch die Ausbildung seiner eigenen Organe aufgiebt emancipirt er sich vom Ganzen und gewinnt die Befahigung freier Existenz." Further on he speaks of incipient metamery as "eine stellenweise, für den Organismus praktisch werdende Ausbildung" of the different organ systems.

before Bateson drew renewed attention to the numerous points of agreement between *Balanoglossus* and the Chordata, M'Intosh had done the same for *Balanoglossus* and the Nemertea, a separate paragraph of his monograph (**XIX**) being devoted to the discussion of these homologies.

Sedgwick (*loc. cit.*) holds the unsegmented worms to be wholly "negligeable quantities," at any rate superfluous links in the chain that connects the Chordata with the antecedent Diploblastic stages. In my idea both these authors, valuable as certain of their suggestions are, have not been thoroughly aware of the necessity that, in all discussions on the origin of metameric segmentation, we must attempt to grasp at data that give a clue to the possible action of natural selection in the gradual evolution of metamery. This clue appears to me to be far more distinctly contained in the views here advocated than in the other hypotheses.

It may further be remarked, now that we have once more alluded to Bateson's phylogeny of the Chordata, that even this naturalist does not feel justified in wholly rejecting the Nemertea from the Vertebrate pedigree. Whilst in the text of his article (*loc. cit.*, p. 566) he does seem to prefer this negative alternative; still, in the subjoined diagram of the general relationships of Urochorda, Hemichorda, Cephalochorda, and Vertebrata, the Nemertea are introduced—with a point of interrogation, however—as a side branch lower down on the common parent stock. Now, this being concordant with my own views of the Chordate phylogeny,—the point of interrogation excepted,—it is necessary to inquire why there is this discrepancy between Bateson's speculations in the body of his treatise and the hypothetical pedigree at the end of it. It appears to me that this is due to his hesitation (*loc. cit.*, p. 555) in accepting the views hitherto entertained and advocated by myself as to the phylogenetic connection between the Nemertean and the Vertebrate nervous system. For this hesitation Bateson has good reasons, and while I appreciate the soundness of them, I hope in the remainder of this chapter to remove the reluctance of him and others to accept the phylogenetic significance of the Nemertea, thanks to new light that may be thrown on the evolution of the central nervous system of the Chordata by the observations above recorded on the nervous system of the Challenger Nemertea.

It is to these speculations on the nervous system that we now have to turn our attention.

As will be seen from the terminology introduced in the paragraph on the nervous system (p. 76), and as it is now time more fully to develop, I am inclined to attach considerable morphological importance to the arrangement of the different constituent parts of the nervous system in the Nemertea. In former publications (**X**, **XI***a*) I have repeatedly insisted on the significance of certain points in the anatomy of the Nemertea, when considering the general question of the relationship of the Chordata to their unknown invertebrate ancestors, and I have insisted not only on the possibility of the homology between the Nemertean proboscis and the hypophysis cerebri of the Vertebrates, but I have, even earlier still, attempted to show that the nerve-system of these two groups might be considered in a common light, as was first indicated by Harting in his Leerboek van de Grondbeginselen der Dierkunde of the year 1874. Further reference to the hypothesis here alluded to is found in Balfour's Monograph on the Elasmobranch Fishes (pp. 170–172), in my own publications (**IX**, **X**), and in Balfour's Comparative Embryology[1] (vol. ii. p. 258). I will not here enter upon this hypothesis more fully, but will briefly state that it attempted to consider the central nervous system of the Vertebrates as a possible median coalescence of two nerve-trunks, that were lateral in the primitive ancestors of the Vertebrates, in the same way as the coalesced ventral nerve-cord (Bauchmark) of Annelids and Arthropods may be considered with Gegenbaur as having arisen out of a double lateral trunk, which in certain, still more highly differentiated forms have fused ventro-medially.

A strong argument against the first-mentioned hypothesis is the fact that the spinal cord ontogenetically always makes its appearance as a median unpaired plate or thickening, a very faint trace of a possible double origin of this plate being hitherto only observable in one species of Amphibia, *Triton tæniatus;* whereas in all other vertebrates, *Amphioxus* and the Cyclostomata not excepted, the unpaired origin is most evident. The bilateral symmetry of the full-grown brain and spinal cord is a much later feature, and can hardly be regarded as the expression of a primary coalescence of two separate halves to form a median whole.

I am the more inclined to abandon this hypothesis, because I will attempt to show that we can establish phylogenetic comparisons between the Chordate and the Nemertean nervous system on a much more simple basis; comparisons which at the same time cover a far more extensive ground than did those of Harting, Balfour, and myself, which I have just alluded to.

Since in the nervous plexus of all the Nemertea a median longitudinal tract, sometimes of comparatively large size, has now been detected, since even in the Hoplonemertea, where the plexus has disappeared, the same medio-dorsal nerve-tract has in most cases been preserved, and, finally, since from this dorso-median stem metameric and paired nerve-tracks may be seen to emerge in Palæonemertea and Schizonemertea, we must inquire in how far the direct comparison of this medio-dorsal nerve-stem with a primitive spinal cord may be said to hold good.

In order to do this we must first consider the relation of this stem, to which we have given the name of medullary nerve or medulla, to the rest of the nervous system, more

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[1] It may here be remarked that Balfour has omitted to mention that Harting was the first to bring forward this hypothesis: it is well to be reminded of this when Beard, Bateson, and others similarly ignore this claim to priority of my venerated predecessor.

especially the brain-lobes.[1] In a former publication (IX), where the medullary nerve was for the first time noticed and described as the proboscidian-sheath-nerve, I traced its origin to the dorsal commissure between the two lateral halves of the brain (*loc. cit.*, pl. i. fig. 1). Thanks to certain very favourable specimens in the Challenger collection, I have now been able to add new data to this statement. Sections through the brain of *Cerebratulus macroren*, *Cerebratulus corrugatus* and *Cerebratulus angusticeps* (Pl. XII. figs. 1, 7, 8; Pl. XIII. fig. 1) show that the condition of things is indeed less simple than this original statement would imply,—that the medullary nerve is not an eminently fibrous cord springing at right angles from the eminently fibrous upper brain-commissure, but that the nerve-tissue constituting the foremost and uppermost portions of the upper brain-lobes spreads out over a far more considerable surface than the fibrous tract which is known as the dorsal commissure. This expansion of nerve-tissue, in which the cellular elements are no less conspicuous than the fibrous, is posteriorly directly continuous with the plexus above described, laterally with the brain-lobes, anteriorly with the cephalic nerves springing from these lobes. It attains its fullest development just before and behind the region where a transverse bundle of fibres uniting the fibrous core of the lateral brain-lobes forms the well-known dorsal brain-commissure. This commissure is a transverse fibrous tract forming part of a more extensive nerve-plate. To this expansion of nerve-tissue the presence of nerve-cells gives a more primitive, at any rate a less specialised, character. These nerve-cells and nerve-fibres are directly continuous with those of the medullary nerve and (backwards) with those of the nerve-plexus, of which this nerve is only the median longitudinal thickening. There is even more reason to look upon the fibres of this medullary nerve as a tract of the general fibrous stroma not necessarily connected with the fibres of the brain-commissure. In other cases a more direct continuity between the commissural and the medullary nerve-fibres was however observed.

In order clearly to understand the relative importance of the different parts of the nervous system here noticed, the primitive Palæonemertea offer the best starting-point.

Thus in *Carinella* we find the brain-lobes not yet separated into distinct upper and lower lobes, nor do we find a posterior lobe (side-organ). The brain is a double lateral and anterior thickening in the nerve-plexus, situated like it and like the lateral nerve-stems outside the muscular body-wall in the deeper strata of the integument. The only difference between the medio-dorsal medullary nerve in this species and the lateral nerves with their anterior enlargements (the brain-lobes) is its position and its greater tenuity (Pl. XVI. fig. 1), which, however, does not prevent its being very clearly observable in every transverse section (Pl. XI. figs. 3, 4). Its connection with the brain-commissure was already described (IX, p. 25), and figured by me (*loc. cit.*, pl. iii. fig. 31). It must,

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[1] In the course of these considerations a certain amount of repetition of facts already noticed in the paragraph on the nervous system cannot well be avoided.

however, be remarked that in these most primitive Palæonemertea, the anterior dorsal brain-commissure is less significant than in the Schizonemertea, and hardly anything else than the foremost of those numerous transverse metameric tracts in the plexus (*dcr*, Pl. XVI fig. 1) which connect the lateral stems with the medullary nerve (dorsally) and with each other (ventrally).

These important metameric nerve-pairs are most distinctly observed in *Carinella*. Here, as in the Schizonemertea, the medullary nerve is also continued forwards in front of the brain thickenings. This continuation sometimes shows a short bend just on the level of the commissure, so that both the medullary nerve and its anterior continuation may be seen in one section. This explains at the same time the arrangement traced on Pl. XII. fig. 8. Posteriorly the medullary nerve can be followed down to the hindmost extremity of the body. In *Eupolia* and the Schizonemertea the arrangement remains the same, the metamery of the transverse stems is perhaps more clearly expressed, the whole plexus and the longitudinal stems are no longer in the integument, but between the muscular layers. Still the whole of the nervous system also answers to the general type as represented in the diagrammatic fig. 1 on Pl. XVI.

We have now seen enough of it to understand that a comparison with the central apparatus of the Vertebrate nervous system cannot indeed be called a strained comparison. On the contrary, the comparison is much less artificial than was the one which Balfour was inclined to adopt, and which, as noted above, rendered necessary the acceptance of the phylogenetic development of the Vertebrate medulla out of a *double* cord.

And so I do not hesitate to proclaim the medullary nerve of the Nemertea to be a very important link in the phylogenetic chain, of which the Vertebrate spinal cord is the outcome. Like the Nemertean medulla, the Vertebrate spinal cord is median, unpaired, and composed of nerve-cells and nerve-fibres; like the Nemertean medulla, it is a thickening in a nervous plexus, originally wholly epiblastic, of which, among Vertebrates, the Amphibian embryos offer such a striking example. This instructive and suggestive case was known to Remak and Stricker (as the "Nervenschicht" of the frog embryo), it was more carefully studied and elaborately described by Goette (his "Grundschicht" of the epiblast, in his Entwickelungsgeschichte der Unke), and it has been again recently brought into the foreground by Baldwin Spencer, in his latest paper on the subject.[1] The latter author compares the Amphibian plexus with that of Palæonemertea and Schizonemertea (*loc. cit.*, p. 134), as had already been done before him by my friend Professor Ray Lankester, with whose suggestion I at that time (1880) did not yet venture fully to associate myself.

The numerous data that have since been accumulated for a direct comparison of Nemertea with lower Vertebrates appear, however, now to fully justify that comparison

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[1] Baldwin Spencer, Some notes on the early Development of Rana temporaria, *Quart. Journ. Micr. Sci.*, vol. xxv. Suppl., p. 123, 1885.

which was first expressed in a footnote to a former paper of mine (**X**, p. 438). There can hardly be any doubt as to the existence, consequent upon natural selection, of a constant tendency in the different component parts of living organisms towards simplification and increased efficiency (Roux's Kampf der Theile im Organismus). This fact enables us to understand the gradual supremacy of the median cord in the Nemertean plexus over the two lateral ones. It seems as if it were mathematically demonstrable that for the delicate adjustment of the impressions from the exterior to the co-ordinated movements thereby occasioned, one longitudinal central stem in bilateral, lengthened animals, would be more efficacious than two lateral ones. And if we ask if, at the final stage of this struggle for supremacy between three longitudinal stems, any remnants of the lateral cords are yet detectable in the Vertebrate embryos, perhaps even in the adults, I am inclined to answer in the affirmative. Here I must be allowed to insert a reference to the three figures on Pl. XVI., which will facilitate the exposition of the further consequences of the hypothesis I am here developing. Fig. 1 represents the chief points in the nervous system of the Nemertea. The brain-lobes are simple lateral swellings of the longitudinal stems, as in *Carinella;* plexus, medulla and transverse stems, together with brain-lobes and lateral stems, may be considered as forming part of the integument (*cf. Carinina*). A double innervation of the respiratory portion of the intestine is indicated; one due to visceral branches (*vi.sy*) springing from the plexus (or from its transverse tracts), the other to the more specialised nerve (*v*), which has above been indicated as the Nemertean vagus nerve. The plexus and its innumerable radial fibres, both sensory and motor, are not indicated in this figure, nor are the nerve-stems which, when present (Pl. XIV. fig. 2), pass from the lateral stems directly to the integument.

This figure must now be compared with the two others. Of these, Pl. XVI. fig. 2, diagrammatically represents the chief points that may be considered as characteristic of the nervous system of a lower Vertebrate, in which the dorsal and ventral roots of the spinal nerves (*dr* and *vr*) are as yet separate nerve-tracts, in which the sympathetic nerve system is as yet only represented by visceral branches given off by these dorsal roots (*vi.sy*), and in which the polymerous character of a primitive vagus (*Vag*) is established.

Pl. XVI. fig. 3, stands for *Amphioxus*, as far as we know its nervous system, more particularly through the researches of Rohon and others. It differs from the foregoing by the absence of a distinct brain swelling, and of a polymerous vagus. A number of spinal nerves are considered as homologues to the vagus of Vertebrates by Rohon. The commissural connections between the successive spinal nerves form a plexus, which is peripherally even much more elaborate, according to Rohon's figures. This plexus does not reveal the presence of any distinct lateral longitudinal nerve, nor any ganglia of spinal or cephalic nerves. The latter (*cn*) may be said to be three in number. Visceral branches (*vi.sy*) are given off by the dorsal nerves (*dr*). The ventral ones, springing from the lower edge of the medulla, are here represented as shorter stems (*vr*).

The opposite half of the system, seen in transparent perspective, as given in the two other figures, is purposely omitted here, because of the asymmetry of *Amphioxus* in this respect.

Now a glance at these figures will convince us that the situation of the Nemertean medullary nerve in its plexus, and with its set of transverse nerves, is directly comparable to the Vertebrate medulla and spinal nerves. The nerve-plexus filling up the intervening spaces in Nemertea is present as a transitory structure in Amphibian embryos.

The ulterior appearance of an anterior enlargement forming the Vertebrate brain; the higher complication attained by the brain and spinal cord when its mass increases, but not its dorsal expansion, by the appearance of medullary ridges; and the formation of a neural canal by infolding of the neural plate, all these are important developmental facts which do not in any way weaken the grounds for comparison of the two structures. They may be looked upon as adaptations to the much more considerable efficiency and concentration that is gradually attained by the central nervous system as we ascend higher in the scale of the animal kingdom.

The fact that the neural ridge in so many Vertebrata precedes the appearance of the spinal nerves, and is inserted along the top of the folds that bend together to form the neural tube, may be thus interpreted, that during the phylogenetic process of infolding, the transverse nerve-tracts (dorsal spinal roots) remain attached in the same way to the medio-dorsal collecting trunk as they did in the ancestral forms, and are dragged upwards by the infolding process. The ventral roots must be phylogenetically linked to the plexus as well; inasmuch as the musculature originally lies inwards of the nervous plexus, their deeper situation is not surprising.

In the points hitherto enumerated there is entire coincidence between *Amphioxus* and the other Vertebrata, as far as their comparability with the Nemertean diagram goes. Another point of coincidence is the way in which the foremost portion of the intestinal canal and adjacent blood-vessels are innervated by visceral nerve-stems, indicated in all the three diagrams by *vi.sy.*

The claims to validity of the comparison here made between the spinal nerves of the Chordata and the transverse stems of the Nemertea, should be again insisted on, now that the researches of Rohon,[1] Freud,[2] Schneider, Ransom, and d'Arcy Thompson[3]

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[1] V. Rohon, Untersuchungen über Amphioxus lanceolatus, *Denkschr. d. k. Akad. d. Wiss. Wien*, Bd. xlv.

[2] S. Freud, Ueber Spinalgangliën und Rückenmark des Petromyzon (*Sitzungsb. math.-nat. cl. k. Akad. Wiss. Wien*, Bd. lxxviii., Abth. 3, 1878). This author says (p.154): "Ich kann wenigstens von den letzten Wurzeln des Caudalmarks sagen dass ihre Selbständigkeit so gross ist, dass man von vorderen und hinteren Spinalnerven, anstatt von vorderen und hinteren Wurzeln reden könnte"; and Wiedersheim in the 2d edition of his Lehrbuch der Vergleichenden Anatomie (p. 321): "Vieles spricht dafür dass die Vorfahren der heutigen Wirbelthiere *getrennte* dorsale und ventrale Nervenwurzeln besessen haben mussen."

[3] W. R. Ransom and d'Arcy W. Thompson, On the spinal and visceral nerves of Cyclostomata, *Zool. Anzeiger*, No. 227, July 1886.

have established for the lower Chordata (Cephalochorda and Cyclostomata) that the typical chordate spinal nerve is not originally provided with a double root, but that this double root appears to have arisen by the coalescence of what were primitively in the groups just mentioned, separate and alternating dorsal and ventral nerve-tracts. With these so much simpler spinal nerves the transverse nerve-stems of the Nemertea undoubtedly offer points of comparison. These Nemertean nerves specially differ from the Vertebrate spinal nerves in two respects: (1) they give off nerve-fibres in different directions, which are probably motor as well as sensory and visceral, according to the different organ systems they terminate in; and (2) they go round ventrally, each of them forming a loop all round the body. As to the first point of difference just alluded to, it is the expression of a low and primitive degree of differentiation, and when a step forwards is made, differentiation of labour will tend to develop certain tracts more particularly containing sensory and visceral nerve-fibres, which are more especially directed towards the epithelia (the primitive dorsal or posterior roots), and others more particularly containing motor nerve-fibres, and more especially directed inwards towards the muscles (the primitive ventral or anterior roots), because the musculature, as was already mentioned, is originally situated internally to the nervous system.

For the present we can only hold it to be established that the fibres of these three categories are blended in the Nemertean plexus, without being able to determine in how far the specialisation therein observed, of the appearance of transverse metameric nerves, may at the same time be accompanied by a commencement of differentiation, such as has just been alluded to. We may, in other words, not yet assume that among these metameric stems there is already a tendency to an alternation between such as have sensory and visceral, and such as have motor predispositions.

Only in a few cases may we be justified in saying that certain nerve-tracts belonging to the Nemertean peripheral system are more especially sensory (Pl. XIV. fig. 2) or visceral (Pl. XIV. fig. 4), and these no doubt offer important analogies in their situation and connections to similar nerve-tracts of the Vertebrata.

The second point of difference, viz., the continuity in the ventral median line of the transverse tracts of the Nemertea, is no doubt a consequence (*a*) of their origin in a perfectly continuous plexus, (*b*) of the cylindrical arrangement of the muscular layers, which in most cases are uninterrupted both in the dorsal and in the ventral median line. It is all the more important to notice, that more especially in the primitive Carinellidæ, the tendency is very marked towards a scission of this muscular body-wall into a right and a left half (*cf.* p. 72). A comparison of figs. 4, 5 on Pl. XI. will show this. In the Schizonemertea, too, and in *Eupolia* it affects the primitive muscular layer (Pl. XI. figs. 10, 12), in a more or less marked degree.

This longitudinal scission is no doubt the first expression of the phenomenon which shows us the musculature of the right and left half of the body, developing quite independently in the Chordata. It is easily intelligible how, as this phenomenon gradually becomes more and more marked, no more ventral connecting fibres across the non-muscular region were required for the innervation of the musculature of the right and left half of the body.

The process by which the transverse nerve-tract, with radial nerve-fibres leaving it at short intervals, both centripetally and centrifugally gradually assumed the form of a nerve-stem with a dorsal and a ventral branch, such as we find in the spinal nerves, must have gone on *pari passu* with those numerous other changes, which we cannot as yet fully trace, but which must have occurred when (1) the muscular metamery became gradually established, (2) the dorso-median medullary tract became so preponderant that an increase in mass, with economy of bulk, was only to be obtained by a process of folding-in already discussed above, and (3) the attachment of the spinal nerves (transverse tracts) to the medulla was modified in consequence of this process.

None of these phenomena, however, offer anything that is in any way inconsistent with, or opposed to, the general theory here developed.

We have now sufficiently insisted on the chief point of comparison here proposed, viz., that between the Nemertean medullary nerve and its metameric transverse nerve-cords, and the Vertebrate cerebro-spinal axis and spinal nerves.

If *Amphioxus* were the only Vertebrate known, we should, recognising the phylogenetic importance of the plexiform arrangement still met with in the adult of that species, admit that, as far as we know at present, the primary lateral nerves with their anterior swellings of the Vermian ancestors had disappeared in the same measure as the dorso-median spinal cord had come more and more into the foreground.

But our consideration of other Vertebrates leads us to the conclusion that, when once the general homology between the two nervous systems is admitted, there may perhaps be secondary points in regard to which the comparison can be further extended. And it must be recognised, that if we should also succeed in rendering more or less probable a comparison in secondary details, this might again be favourably interpreted for the primary and more important part of the hypothesis.

The search after these secondary points of agreement was instituted by me, when the question above alluded to presented itself, viz., if any remnant could be traced of the central nervous system of Nemertea-like ancestors, *i.e.*, of the brain-lobes and lateral stems, in those Vertebrate descendants in which the medio-dorsal tract had become so preponderant as to give rise to the unpaired medulla and brain.

It is clear that if it shall be possible to trace any such remnants, and to render their homology with the Nemertean central nervous system probable, they will have to be sought for—(*a*) in the head, as lateral more or less independent nerve-centra, innervating sense-organs of the integument, and passing posteriorly into parallel longitudinal stems; or (*b*) in the trunk, as longitudinal nerve-stems, in which the central character should be somewhat less marked than in the anterior swelling, but in which the original significance as parts of the central system should still be indicated either by histological or by embryological features.

To these latter conditions nothing can answer in the Vertebrate nervous system excepting the so-called ramus lateralis vagi. It is present in all Vertebrates above *Amphioxus*, long and important in the aquatic Ichthyopsida, gradually disappearing when the aquatic medium is exchanged for an air-breathing existence, and finally only retained in the higher Vertebrates as the inconspicuous ramus auricularis vagi.

Its course is indeed strictly lateral, and has always been a puzzle to anatomists. Stannius[1] characterises the existence and the course of this sensory nerve along the trunk down to the tail as "one of the most interesting facts of anatomy."

None the less startling is its development. Whilst Balfour attempted in this respect to bring it on one line with the other parts of the peripheral nervous system, the corresponding results of Semper, Goette, van Wijhe, and Hoffmann are all in the contrary direction. They have seen the nervus lateralis appear as *an independent product of the epiblast*, arising *in loco* along its whole length, its formation often even preceding that of the spinal nerves. These results have again been fully confirmed and definitely established by the latest investigator of the problem, Beard,[2] who also gives a detailed description and figures of the connection between the nervus lateralis and the vagus ganglion, both of them so much more massive and conspicuous in early embryonic stages than later on.

And now that we are attempting to find out whether there is a possibility of comparing the lateral nerve-stems of lower worms with the nervus lateralis of Vertebrata, we are naturally led to consider, in the second place, the question whether the anterior swellings of these lateral stems (the paired brain-lobes of the worm) may have their morphological equivalents, their remnants, in the set of anterior nervous swellings that are found in the head on a level with the nervus lateralis, and longitudinally connected with it; viz., the variable set of ganglia of the cephalic nerves.

As to the origin of these ganglia of the cranial nerves I have no observations of my own, and must rely on the data of other observers.

It is suggestive to give the opinion of the three latest investigators of the development of these organs in different groups of Vertebrates in their own words.

Professor A. Froriep,[3] who studied Mammalian embryos, writes (*loc. cit.*, p. 35):—"The ganglia (of facialis, glossopharyngeus, and vagus) enter into a peculiar, very intimate connection with the epiderm"; further (p. 40), "these ganglionic connections with the epiderm must probably be regarded as rudiments of organs which have phylogenetically

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[1] Das peripherische Nervensystem der Fische, p. 108.

[2] The System of Branchial Sense-Organs, &c., in Ichthyopsida, *Quart. Journ. Micr. Sci.*, November 1885, p. 95.

[3] Ueber Anlagen von Sinnesorganen am Facialis, &c., *Archiv f. Anat. u. Phys.*, 1885, Anat. Abth.

disappeared, and which are only now retained in the ontogenetic development"; then (p. 43) "for the Gasserian ganglion there is no indication of a connection with the epiderm"; and, lastly (p. 52), "it appears to be hardly any longer possible to look upon these nerve-ganglia (Nervenknoten) as simply homologous with spinal ganglia."

Baldwin Spencer[1] writes (*loc. cit.*, p. 129) concerning *Rana temporaria*:—"Along certain lines the cells of the nervous layer proliferate, and it is by this proliferation that the rudiments of the cranial nerves are laid down"; further (p. 130), "the development of the ganglia at the level of the lateral line, and the fact of their long connection with the epiblast at this point . . . . is of great interest in connection with certain points in the development of the Elasmobranch nerves."

Concerning the developmental phenomena in the trunk-region at this period, the spinal nerves are stated to be not yet visible, "though the nervous sheath is clearly developed and in this the lateral line"

The author next mentions observations made by him on Dr. Beard's sections of Elasmobranch embryos, and goes on to say (*loc. cit.*, p. 131):—

"The Gasserian ganglion is, at all events in part, formed *directly from the epiblast* . . . . the same development takes place in the case of the ganglion of the third and seventh nerve—in that of the ciliary ganglion the development is particularly clear— . . . . *The ganglia arise along a level of the lateral line continued on the head.*"

He next says:—"The curious origin of the ganglia of the cranial nerves points strongly to the conclusion that . . . . their present condition and nature must . . . . be regarded as a secondary and certainly not primitive condition.

"In passing, I may just notice that on this supposition an explanation is offered as to the origin and meaning of the two curious branches which unite respectively the ganglia of the fifth and seventh and fifth and third cranial nerves; they may be regarded as persistent parts of the lateral nerve . . . . in the head."

In the third place, extracts will be given from Beard's more extensive paper.[2] He writes (p. 97) as an introductory statement:—"At present we are acquainted with no Invertebrate nervous system which is built upon the same plan as that of Vertebrates"; and then passes to the results of his investigations chiefly carried out on embryos of *Torpedo* and a few other Elasmobranchs. I make the following selections (p. 101):—

"At the point of fusion" (of the cephalic nerve with the epiblast) "a local thickening of epiblast has previously taken place. After the fusion has taken place a proliferation of some of the cells composing the thickening ensues. The proliferated cells form a mass of actively-dividing elements still connected with the skin. . . . . This mass of cells is the rudiment of the ganglion of the dorsal root."

On p. 110 he adds:—"Along with the separation of the (vagus) ganglion from the

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[1] Early Development of Rana temporaria, *Quart. Journ. Micr. Sci.*, Suppl., 1885.

[2] Branchial Sense-Organs in Ichthyopsida, *Quart. Journ. Micr. Sci.*, November 1885, No. ci.

skin, the sensory thickening begins to grow backwards along the lateral surface of the trunk. This thickening is the rudiment of the so-called lateral line. . . . . The so-called lateral nerve is formed from the deeper portion of the sensory thickening. . . . . That there is no actual growth backwards of the nerve is obvious enough."

Recapitulating, we must acknowledge that the mode of origin of the ganglia of the cephalic nerves, as described by these authors, is certainly a peculiar one—a mode of development *sui generis*. One of Beard's accompanying diagrammatic figures, reproduced in Wiedersheim's second edition (1886) of the Lehrbuch der Vergleichenden Anatomie as woodcut No. 265, moreover, shows how the position of the cephalic ganglion, developing as an ectodermal proliferation, is in this early stage eminently lateral, a conclusion corroborated by the figures of his actual sections. This primitive position is, of course, gradually lost, and could never be predicted from a study of these ganglia and their position and significance in the adult animal. Yet it is not without significance, when seen in the light of the suggestion here brought forward. And that the interpretation of the phenomena in question as given by these authors is not universally accepted, thus leaving room for new suggestions, is proved by the following citation from Ransom's and d'Arcy Thompson's latest article,[1] running as follows:—"Although the lamprey presents a well-marked lateralis nerve, it has not also a regular lateral line, for the sense-organs of the skin are scattered and without segmental arrangement. The sense-organs do not, therefore, appear to be in direct relation with the spinal ganglia, and the view of the close connection between them (Spencer, Beard, Froriep) does not receive support. . . . . It seems more natural to consider the lateralis as a relic of the extensive and irregular commissure system connecting the posterior roots of *Amphioxus*."

Passing from a consideration of the embryonic ganglia to their connection in the adults, I must mention the connection of the ramus lateralis vagi with cephalic nerves anterior to the vagus. I will not here give a description of the numerous varieties presented by this nervous connection, but merely refer to the arrangement in Vertebrates so low as the lampreys. We there find, according to Johannes Müller, the ramus lateralis originating from the seventh as well as from the tenth pair of cephalic nerves, and if we compare the very satisfactory figure which was only lately[2] given by Ahlborn of this arrangement, we must recognise that this nervous connection is important, and has more the aspect of a direct forward continuation of the nervus lateralis than of a sensory branch from the facialis, establishing a connection between it and the vagus.

Ahlborn mentions the existence of a similar connecting stem reaching further forward still, and connecting the trigeminus and facialis. How these connections vary in the different adult Vertebrata will not be discussed here.

The different facts and speculations here brought forward in connection with the

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[1] On the Spinal and Visceral Nerves of Cyclostomata, *Zool. Anzeiger*, No. 227, July 1886.

[2] *Zeitschr. f. wiss. Zool.*, Bd. xl., pl. xviii.

cephalic ganglia and the nervus lateralis vagi, may suffice for the present. They may severally be brought to bear upon the question of the eventual homology of Vertebrate cephalic ganglia and nervus lateralis, on the one hand, and Vermian paired brain-lobes and lateral nerve-stems, on the other. The parts here compared, being indicated in figs. 1 and 2 of Pl. XVI. with corresponding letters, *Lg* and *ln*, a glance at these figures may further convey a notion of the purport of these speculations.

There is one fact, however, which is not indicated in these figures, which is nevertheless of very high importance for the views here considered, and which I must therefore develop more in detail.

It is the connection between the successive spinal nerves and the ramus lateralis vagi.

The existence of similar connections between the (eminently sensory and cutaneous) dorsal roots and the (similarly sensory and cutaneous) lateral nerve is for the first time mentioned by Ransom and d'Arcy Thompson for *Petromyzon* in the following passage (*loc. cit.*, p. 422):—

"The dorsal rami of the posterior roots pass up (over the lateralis nerve) to the skin of the back, but appear also *to send fibres into the lateralis.* (For this statement we at present rely only on sections, but we hope shortly to test it by dissections of the large *Petromyzon marinus.*)"

It hardly needs comment that if this observation should be confirmed the fact would be of the utmost importance for the hypothesis under discussion. We should then be permitted to consider these metameric connections between the dorsal roots and the nervus lateralis of *Petromyzon*, as the relics of an earlier stage, still permanent in the Nemertea, where the metamerically consecutive transverse nerve-tracts similarly unite the medullary nerve and the lateral stems.

This connection is, as we know, also brought about in the Nemertea by the plexus, in those parts of it which spread out between the transverse tracts, and it may here be asked if relics of such a plexus between the successive precursors of the spinal nerves are perhaps retained, not only in *Amphioxus* (see above, p. 134, and Rohon, *loc. cit.*, fig. 13), but also in Osseous Fishes in the numerous superficial nerves described and figured by Stannius,[1] or whether we must rather look upon this multiplication of lateral nerves (one of which is called by Stannius the nervus lateralis trigemini, others, rami communicantes of the dorsal branches of spinal nerves, &c.) as derivatives from the nervus lateralis vagi.[2] This question can, of course, only be solved by careful anatomical and embryological investigations. That the nervus lateralis was often (Stannius) observed in the Petromyzontidæ only along a part of the length of the body (Schneider and Born, according to Ahlborn,[3]

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[1] Das peripherische Nervensystem der Fische, 1849, pls. ii.–iv.

[2] It should be remembered that Beard is inclined (*loc. cit.*, p. 139) to look upon the superficial longitudinal nerve-fibres, by which the successive epithelial modifications along the lateral line are often connected (Solger, Bodenstein), as such derivatives (by longitudinal fission in its very early stages) of the nervus lateralis.

[3] *Zeitschr. f. wiss. Zool.*, Bd. xl. pp. 303 and 304.

observed it "bis an das Hinterende des Körpers") is not confirmed by modern investigators. Ahlborn's description (*loc. cit.*, p. 304) of the variable situation of this nerve in *Petromyzon* is very suggestive in connection with the views here advocated. Ransom and d'Arcy Thompson consider that the regularity of the integumentary sensory apparatus is not yet established in *Petromyzon*, as may be concluded from the citation given above (p. 140).

We have now considered the superficial ramifications of what I may call the lateral nerve system, both in lower worms and in Vertebrates; we must now turn to the intestinal, to the visceral branches of this same system, from which other and important data may be gathered for further elucidation of the hypothesis under consideration.

We have already seen that in Nemertea the typical innervation of the respiratory portion of the intestine is brought about—(*a*) by a pair of nerves directed backwards and springing from the anterior lateral swellings (the brain-lobes) of the lateral nerve-stems; (*b*) by numerous visceral branches starting from the plexus, directed inwards as branches that spread over the wall of blood-lacunæ and intestine.

In the Vertebrata, *Amphioxus* excepted, we also find that the innervation of the anterior respiratory portion of the intestine and of the circulatory apparatus is obtained from two sources, viz., (1) the cephalic nerves, amongst which the vagus nerve is in this respect the most important[1]; (2) the visceral branches of the spinal nerves, which are at the basis of what is afterwards more highly differentiated and separately recognised as the sympathetic nerve-system.

In Nemertea it is very difficult to determine in the anterior part of the intestinal wall, which tracts belong to the so-called vagus nerve, which to this system of visceral nerve-branches.

So it is often in Vertebrata, and the blending together (in both divisions of the animal kingdom) of two systems, each of them again mutually comparable when separately considered, is an important point of agreement, and would, if no actual homology were at the base of it, be a very puzzling coincidence.

It is in this respect highly suggestive that Born notices, as early as 1827, what was afterwards confirmed by Ahlborn (*loc. cit.*) and others, that in *Petromyzon*, *i.e.*, one of the lowest Vertebrates, the spinal nerves send out connecting branches towards the pneumogastric nerves. The existence of superficial metameric connections (Ransom and d'Arcy Thompson, *vide supra*) as well as of this set of deeper connections between the transverse and the latero-longitudinal nerve-stems (n. lateralis and n. pneumogastricus) of *Petromyzon* would thus be a most remarkable repetition of the similar arrangement in the Nemertea, as it has been here for the first time demonstrated.

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[1] Ventrally these nerves (*e.g.*, the n. hypoglossus) are sometimes commissurally united with their representative of the opposite half of the body. It must remain an open question whether these commissures are in any way comparable either to the Nemertean vagus commissures (*cf.* p. 83), or to the general ventral commissural system of these worms.

The facts as they lie before us do not, however, admit of any very circumstantial comparison so far as the nerves in particular are concerned, and I purposely refrain from entering into any details. Yet it should be remarked—

(1) That the polymerous root of the Vertebrate vagus nerve is very readily explicable if we take the Nemertean arrangement as a starting-point (Pl. XVI. figs. 1, 2, *vag*), as is also the mixture of sensory and motor elements in this root.[1]

(2) That similarly, if the anterior cephalic nerves (*e.g.*, the fifth) should prove to be polymerous, this would in no way be astonishing nor difficult to bring into harmony with that same starting-point.

(3) That the presence of superficial branches to the integument and to the musculature, and of deeper branches to the intestinal epithelium in those parts that will contribute to form the cephalic nerves, is similarly foreshadowed in the Nemertea.

(4) That the equivalent of the Nemertean vagus nerve will have to be sought for in such branches of the Vertebrate vagus as more especially innervate the intestinal epithelium,[2] whereas the innervation of the Vertebrate gill-slits, which marks a later phylogenetic stage, in which these perforations of the anterior trunk region have appeared, may be as well put to the account of more superficial parts of the transverse tracts.

(5) That the common starting-point of the sensory, lateral, and the intestinal portion of the vagus has also attracted the attention of former observers. Ransom and d'Arcy Thompson write :—" In the embryo dog-fish the second or ventral commissure described by Balfour, &c., as uniting the roots of the vagus, ventral to the ganglia, is essentially a sympathetic commissure, whose (visceral) fibres pass on, as described by Balfour, to form the intestinal branch of the vagus. In that intestinal branch we have an outflow of visceral fibres, quite comparable to, *e.g.*, a splanchnic branch of the dorsal sympathetic system. The connection between the origin of the lateralis and this ventral commissure connecting the vagus roots in the dog-fish, and similarly the relation of the lateralis to the loops uniting the ganglia of the 5th, 7th, and 10th nerves in *Petromyzon* may probably be described as indicating a fusion in this region of the two great commissural systems which posteriorly are separate, viz., that of the sensory branches (lateralis) and the visceral or sympathetic.

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[1] Rohon, Ueber den Ursprung des Nervus vagus bei Selachiern, *Arbeit. Zool. Inst. Wien*, vol. i. p. 159.

[2] I have good reasons, based upon actual observations made by my pupil, Mr. Dobberke, to believe that the ramus intestinalis vagi in adult Elasmobranchs may be traced centripetally from its region of innervation of the foremost portion of the intestinal wall, towards the brain, as a bundle of nerve-fibres running parallel to and combined with those for the branchial apparatus, but that, nevertheless, this bundle can be separately traced up to the vagus ganglion, without any further intimate relation to those branchial branches (*cf.* Beard, *loc. cit.*, p. 110). If this should actually be the case, *the possibility of a direct comparison between the Nemertean vagus nerve and the Vertebrate ramus intestinalis vagi*, of course, comes more closely within our reach. It need not be insisted upon that if these comparisons prove correct, the separate intestinal nerve-systems (sympathetic nerve system) of other Invertebrates (Annelids, Arthropods, Molluscs) cannot be looked upon as homologous with the sympathetic nerve system of the Vertebrates, but would rather be homologous with that portion of the intestinal innervation of the latter which comes to the account of their cephalic nerves, in so far as these represent derivatives of the Nemertean vagus, and are marked *v* in figs. 1 and 2 of Pl. XVI.

"We agree with Gaskell that the term sympathetic should be suffered to fall into disuse, as tending to perpetuate the old conception of the primary importance of the longitudinal nerve-tract; whereas the leading fact is the metamerically recurring outflow of visceral fibres, which may or may not be united together by successive longitudinal commissures."

In the Nemertea this anterior "fusion of the great commissural systems" is foreshadowed at the point where brain-lobe, lateral stem, and "vagus nerve" meet, or rather diverge. It has been attempted in figs. 1 and 2 to indicate the points here alluded to in a general way, special comparisons being, on the grounds that have been stated, purposely avoided.

If we now turn to Dohrn's and Semper's hypothesis we must recognise that no such satisfactory general comparisons are there possible. Even if we were inclined to accept the "turning over" of Geoffroy St. Hilaire, by which back and belly became exchanged, and to admit the brain-piercing œsophagus, regarding the Annelid supraœsophageal ganglion and the ventral nerve-cord as respectively homologous to cerebrum and medulla, it must still be conceded that we have not then in any way before us a nerve system offering as many points of comparison with the Vertebrate system as does that of the Nemertea.

Concerning the Annelids we have no observations by which the cephalic ganglia and the cephalic nerves are so clearly foreshadowed, none which would throw light on the origin of the vagus, its connection with the nervus lateralis and with the anterior cephalic ganglia, none concerning the sympathetic system and its blending with the vagus system in the lowest Vertebrates, indications of which are even retained in the highest. Nor is the ventral nerve-cord of Annelids, with its undeniable *double* character and double origin a match, so far as comparison goes, for the Nemertean medullary nerve, with its transverse nerves preceding the spinal nerves of *Amphioxus* and the Cyclostomata.

And if we are then asked to consider the lens of the Vertebrate eye as a modified ectodermal branchial invagination, as the outer portion of what was once a functional gill-slit,[1] we feel that the ground under our feet is becoming rather uncomfortable, and that it is high time to reconsider whether all these ingenious speculations in which the most beautifully pliable hypothetical and unknown Annelids play a too conspicuous part should not be definitely abandoned, and a new departure made by those who are interested in the phylogeny of the Chordata. In due time arduous and detailed morphological investigations on the Platyelminthes in general, and on the Nemertea in particular, may then lead us to more satisfactory conclusions than are the *fata morgana* that are so temptingly evoked before our eyes by the ingenious manipulations of the indefatigable founder of the first and foremost Zoological Station, when, following his lead, we find ourselves wandering in the barren deserts of that province of phylogeny, in which he attempts to establish a close connection between Chordata and Annelida.

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[1] Dohrn, Studien, x. p. 459, 1885.

All these considerations have induced me to give this rapid outline sketch of the degree of comparison which I hold to exist between Chordate and Nemertean (more especially Palæonemertean and Schizonemertean) nervous systems, although I am perfectly aware that there is a growing tendency among those authors at present occupied with questions concerning the morphology of the Vertebrate nervous system (Froriep, Baldwin Spencer, Beard, Cunningham, Kleinenberg, and many others) to accept Semper's and Dohrn's views of the Annelidan descent of Vertebrates. Wiedersheim, in the new edition of his "Vergleichende Anatomie" (1886), does not even hesitate to bring these results in their unripe phase before the more extensive public of students, and this generally in acquiescent terms. It is curious to see how, *e.g.*, the question of the cephalic nerves and their comparison to spinal nerves, that of the nerve-roots, the cephalic ganglia and their respective connecting trunks, have given occasion to the most diverse twisting and retwisting of the facts in order to bring out a fixed scheme or diagram, which might then be compared to what obtained in Annelids, and in which the highest degree of similarity between the respective somites might be obtained, thus establishing a preconceived idea of the Vertebrate ancestor as a most rigorously segmented animal. The value of these speculations has been already tested above, and I may be allowed once more to express my conviction that our comparisons between the Chordata and their lower Invertebrate predecessors may only be looked upon as in any way satisfactory so long as they remain on a very broad and general basis, and that any very special homology said to be demonstrated ought for that very reason to be more especially suspected.[1]

For my part I believe that, along the lines above indicated, a comparison between Vertebrate and Invertebrate nervous systems will in future prove to be more fruitful, but I wish to repeat that for the present we can only indicate general points of coincidence between the two, and must rigorously refrain from making comparisons in detail.

On the other hand, it is suggestive once more to consider what has been recorded above (p. 89) concerning the nervous system of *Drepanophorus lankesteri*, when compared with that of certain Annelids; and we may, I believe, safely come to the conclusion which was formulated by me seven years ago, but which I now hold to be much more solidly established, that we have in the Nemertea an important group through which definite glimpses may be obtained at the sources from which both Chordata and Appendiculata (Ray Lankester) have respectively sprung. The proposition

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[1] Bateson (*loc. cit.*, p. 562) seems to take a similar view of the efforts here alluded to. He says :—"No doubt the cranial nerves may, by arbitrary divisions and combinations, be shaped into an arrangement which more or less simulates that which is supposed by some to have been present in the rest of the body, but little is gained by this exercise beyond the production of a false symmetry."—Dohrn himself, whose suggestions have so largely contributed to the accumulation of all this conflicting evidence, is now rather in the position of Goethe's Zauberlehrling, and writes (Studien, x., p. 468, 1885)—"Auch auf diesem Gebiet (die Frage nach der Bedeutung der Hirnnerven) bildet die bisherige vergleichende Anatomie das Bild eines auf stürmischer See steuerlos herumgeschleuderten Schiffes."

first formulated by Gegenbaur, about the phylogenetic origin of the ventral nerve-cord and œsophageal ring of the Annelida out of ancestors with lateral cords, has obtained new support from the arrangement which was met with in the species just mentioned. And just as we have before tentatively discussed the question, in how far remnants of the lateral cords were retained in those descendants in which the median one had been raised to the dignity of a medulla spinalis (the Vertebrata), we might now consider whether any remnants of the median dorsal cord are retained in those descendants in which the lateral cords have differentiated into brain-lobes, œsophageal ring, and ventral cord (the Annelida). To this question I have no definite answer to offer, but I may call attention to the significant fact that the beautiful and exemplary investigations into the embryonic development of *Lopadorhynchus*, very recently published by Kleinenberg,[1] have demonstrated the existence in the larva of that Annelid, of a nerve-stem answering to the conditions here required. It is dorsomedially situated, it is anteriorly connected with the brain, or rather with a transverse nerve-tract (Kleinenberg's prototrochal nerve-ring), which in its turn is connected with the brain,[2] it appears to be connected close to the anus with the ventral cord (the fused lateral stems), and though appearing in early larval life, and having only a temporary existence, it is regarded by Kleinenberg as having considerable physiological importance. If the light in which I am inclined to look at it is not deceptive, its morphological significance also can hardly be overrated.

In closing this chapter of general considerations, we may once more bring before our minds the proposition with which it was opened. We have here and in the foregoing chapters adduced facts and arguments which appear to speak in its favour; we will once more rapidly enumerate the common characteristics of Nemertea and Cœlenterata, as well as those of Nemertea and Chordata.

The Cœlenterate characteristics that are also found in the Nemertea are the following:—

a. The presence of nematocysts in the proboscidian epithelium.
b. The elaborate nerve-plexus in the integument, and its histological features.
c. The presence of epiblastic muscle-fibres separate from the general body-musculature.
d. The presence and the chemical constitution of a sometimes very massive intermuscular jelly, by which the other internal organs are at the same time surrounded.
e. The mode of development of the mesoblast (at least in *Lineus obscurus*), which is less specialised than in most other Invertebrates.
f. The absence of any distinct enterocoele.

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[1] *Zeitschr. f. wiss. Zool.*, Bd. xliv., Heft. i, ii., October 1886, p. 107; pl. vii. fig. 27*a*.

[2] For comparison with the Nemertea, *cf.* pl. xvi. fig. 1.

The points of resemblance with the Chordata may be thus tabulated :—

a. The general features of the nervous system.

b. The presence of a homologue of the hypophysis cerebri as a massive and important organ (the proboscis).

c. The presence of tissues which may have become converted into the notochord (viz., the material of which the proboscidian sheath is built up).

d. The respiratory significance of the anterior portion of the alimentary tract.

At the base of all the speculations contained in this chapter lies the conviction, so strongly insisted upon by Darwin, that new combinations or organs do not appear by the action of natural selection unless others have preceded, from which they are gradually derived by slow change and differentiation.

That a notochord should develop out of the archenteric wall because a supporting axis would be beneficial to the animal may be a teleological assumption, but it is at the same time an evolutional heresy. It would never be fruitful to try to connect the different variations offered, *e.g.*, by the nervous system, throughout the animal kingdom, if similar assumptions were admitted, for there would be then quite as much to say for a repeated and independent origin of central nervous systems out of indifferent epiblast just as required in each special case. These would be steps that might bring us back a good way towards the doctrine of independent creations. The remembrance of Darwin's, Huxley's and Gegenbaur's classical foundations, and of Balfour's and Weismann's brilliant superstructures, ought to warn us away from these dangerous regions.

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B. HOPLONEMERTEA—

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II. ANATOMY—

PLATE I.

PLATE I.

Fig. 1. *Carinina grata*, n. gen. et sp. A ventral view of one specimen. Terminal proboscidian opening visible, as well as the terminal ciliated groove, the lateral ciliated groove and the ventral mouth. × about 3½.

Fig. 2. *Carinina grata*, n. gen. et sp. A side view of same specimen, showing the terminal ciliated groove, the lateral ciliated groove and the ventral mouth. × about 3½.

Fig. 3. *Carinina grata*, n. gen. et sp. A ventral view of another specimen, showing the terminal proboscidian opening, and the terminal ciliated groove. × about 3½.

Figs. 4, 5. *Eupolia nipponensis*, n. sp. Right and left lateral view of one of the specimens. Natural size.

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Fig. 10. *Eupolia nipponensis*, n. sp. Another specimen, seen from below. The mouth is very small.

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Fig. 13. *Cerebratulus macroren*, n. sp. Ventral view of tip of head of New Zealand specimen. × 15.

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Fig. 21. *Amphiporus moseleyi*, n. sp. Anterior part, showing cephalic groove and subterminal opening (indicated by a cross fold) which leads into the proboscis and the intestine. Natural size.

Fig. 22. *Drepanophorus lankesteri*, n. sp. Dorsal view. Natural size.

Figs. 23–31. *Pelagonemertes rollestoni*, H. N. M., after Moseley, who explains the figures as follows :—

> Fig. 23. "*Pelagonemertes Rollestoni*, enlarged, viewed from the dorsal surface ; the proboscis is partly extruded ; *Pr.S.*, sac of proboscis ; *IP.*, invaginated portion of proboscis within the proboscis sac ; *G*, superior nerve ganglion ; *N.C.*, nerve cords ; *V*, vascular trunk (the upper *V* points to an enlargement of the vessel lying just posteriorly to the superior nerve ganglion) ; *I*, intestine ; *D*, diverticula of intestine ; *A*, anus ; *OO*, ovaries ; *CM*, circular muscles ; *LM*, longitudinal muscles.
>
> Fig. 24. "*Pelagonemertes Rollestoni*, from the ventral surface, × 2 diameters. 1, Mouth, with œsophagus ; 2, partly protruded proboscis ; 3, nerve ganglia ; 4, nerve-cords ; 5, ovaries ; 6, digestive canal. The sheath of the proboscis is seen through the body lying behind the digestive canal.
>
> Fig. 25. "Sketch of the proboscis-sheath and contained retracted proboscis, from the dorsal aspect. Retractor muscles inserted into the commencement of the sheath.
>
> Fig. 26. "1, One of the polygonal areas, enlarged, showing the wrinkles of integument producing the appearance. 2, Peculiar appearance of some of the folds of the integument.
>
> Fig. 27. "Reticular appearance of the integument observed in certain parts of the body. Natural size.
>
> Fig. 28. "*a*, Groups of brightly coloured fatty globules forming the contents of the diverticula of the intestine ; *b*, portion of the vascular trunk, much enlarged.
>
> Fig. 29. "Portion of the invaginated proboscis, much enlarged. *a*, External gelatinous layer ; *b*, internal muscular layer ; *c*, cavity continuous with that of the proboscis-sac ; within these the invaginated portion of the proboscis with the layers reversed ; *b*, internal muscular layer ; *a*, external gelatinous layer[1] ; *d*, central tube filled with dark amorphous matter (from the proboscis-sac ?).
>
> Fig. 30. "The nervous ganglia and ring, much enlarged. *A*, Superior ganglion ; *B*, inferior ganglion.
>
> Fig. 31. "One of the ovaries, enlarged. The dark irregular line on the centre represents what is probably an aperture for the discharge of ova."

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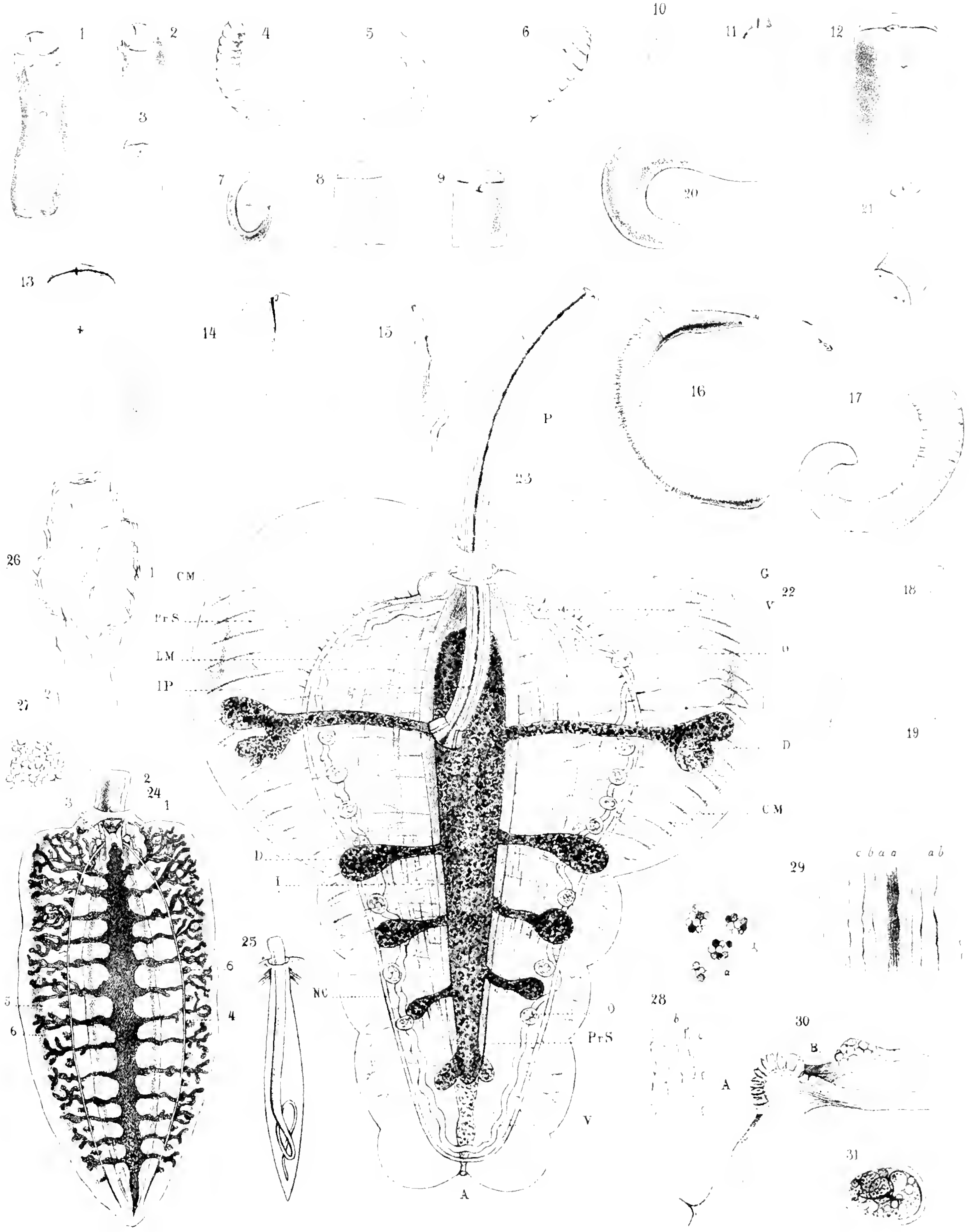
[1] This figure has been incorrectly lettered by the lithographer, *a,b,c* furthest to the right should be *c,b,a*.



CARININA. EUPOLIA. CEREBRATULUS. AMPHIPORUS. PELAGONEMERTES.

Lith J W v d Wagen fec

PLATE II.

PLATE II.

J. Integument.
M. Musculature.
bl. Blood-space.
aPr. Rhynchodæum.
Po. Proboscidian opening.

Ps. Proboscidian sheath-cavity.
Pr. Proboscis.
D. Intestinal cavity.
C. Brain-lobes.
Comm. Inferior brain commissure.

N. Lateral nerve-trunks.
lm, cm. Musculature of the proboscis.
ie. Epithelium of do.
P.N. Nerve-stems of do.

Figs. 1–7. *Carinina grata*, n. gen. et sp. Transverse sections and parts of sections of one of the specimens in which the proboscis was protruded and ejected from the body—drawn with the camera. The integument and what pertains to it is tinted light sepia, the nervous system yellowish, the muscular investment of the body red, the intestinal epithelium grey.

Fig. 1. Section through the tip of the head and the anterior point of meeting (*bl*) of the two lateral blood-spaces. The terminal furrow at the tip of the head (*cf.* Pl. I. figs. 1, 3) has been touched in the left lower corner of the section.

Fig. 2. Section somewhat further back in which the blood-space shows a right and a left portion, and in which the anterior wall of the rhynchodæum (*cf.* fig. 8, *aPr*) has been touched, the first indication of the opening through which the proboscis is thrust forward being also visible in this section.

Fig. 3. Section through the brain thickenings (*cc*), the ventral commissure and the præstomial blind portion of the œsophagus.

Fig. 4. Section through the mouth region. To the left the blood-space appears to be locally subdivided by radial strands of tissue.

Fig. 5. Section through the œsophageal region. The layer of longitudinal and inner circular muscle fibres are separated by a thin black line. The blood-spaces are more or less enclosed in the latter layer.

Figs. 6, 7. Two sections, still further back, of the inner circular muscular layer and what is encompassed by it. These sections show the change in shape which both the proboscidian sheath-cavity and the blood-spaces undergo in different portions of the body.

Fig. 8. *Carinina grata*, n. gen. et sp. A horizontal section through the head, brain-lobes and proboscidian insertion of the second specimen, in which the proboscis had remained attached and inverted (*cf.* Pl. III. fig. 4).

Fig. 9. *Carinina grata*, n. gen. et sp. Section further backwards (*cf.* fig. 3). (The specimen being curved this section and the following are no longer horizontal but transverse).

Fig. 10 *Carinina grata*, n. gen. et sp. Section further backwards still (*cf.* fig. 5).

Figs. 9 and 10, when compared with figs. 3 and 5, give an idea of the change effected upon the body musculature by the inversion and eversion of the proboscis. Some latitude must, however, be left for the fact of the specimens being different.

Figs. 11, 12. *Carinina grata*, n. gen. et sp. Two transverse sections through the proboscis, with the external thin homogeneous layer enclosing the outer longitudinal (brown) and inner circular (red) muscular layer. Inside the latter is the proboscidian epithelium. The two strong nerves of the proboscis are still enclosed in this epithelium, as are the nerve-trunks of the body in the integument.

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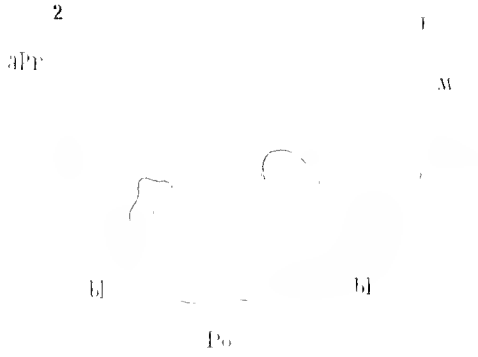

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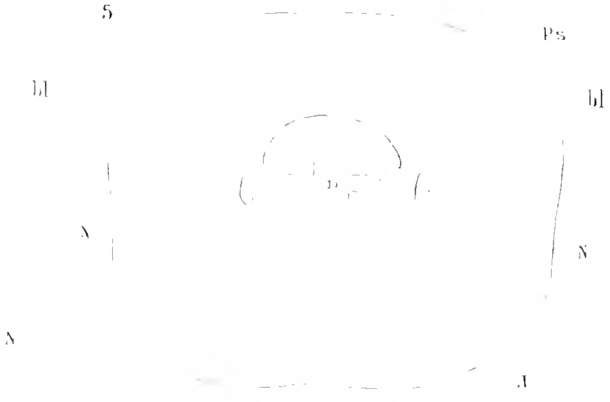

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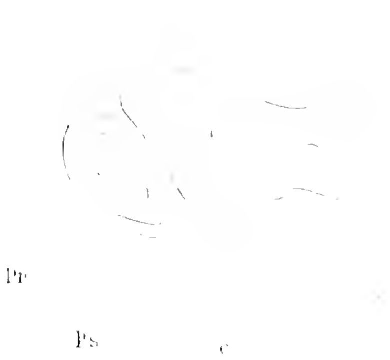

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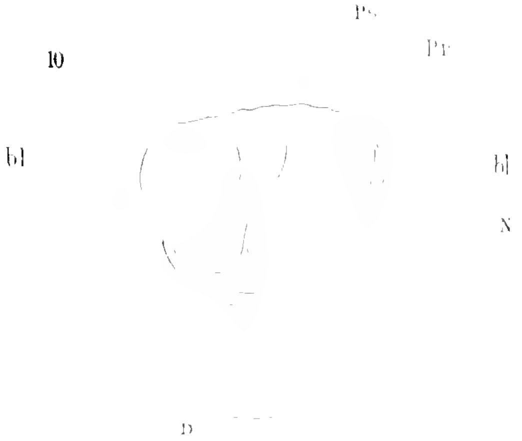

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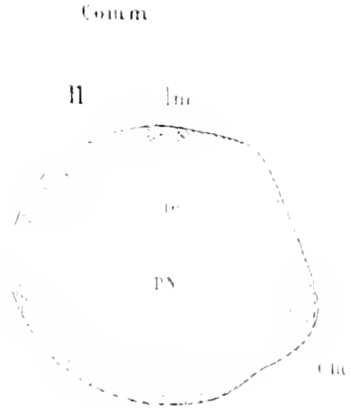

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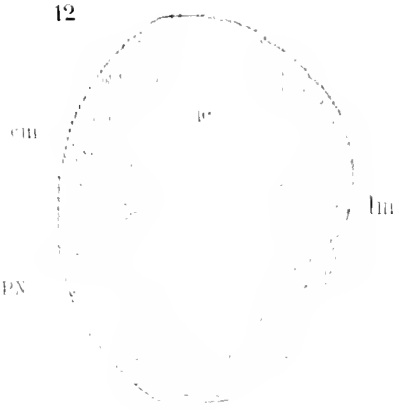


Hubrecht et de Groot del.

CARININA.

PLATE III.

PLATE III.

Fig. 1. *Carinina grata*, n. gen. et sp. Longitudinal section through a loop of the proboscis. In the upper section the proboscidian epithelium (*Pe*) is much more columnar, in the lower one it is thrown into folds and much more loosely applied against the musculature.

Fig. 2. *Carinina grata*, n. gen. et sp. A part of the last mentioned region, more considerably enlarged.

Fig. 3. *Carinina grata*, n. gen. et sp. A longitudinal section through the body-wall. *Cm*, the inner circular muscular layer (δ of Pl. XI.); *LM*, the longitudinal muscles (α of Pl. XI.); *ec*, the outer circular muscular layer (β of Pl. XI.); *B*, the homogeneous basement membrane; *Nl*, the deepest layer of the integument, with plexiform nerve tissue (the lithographer has given too stellate an appearance to these histological elements); *Gi*, the deeper glandular stratum; *E*, the outer stratum of the integument.

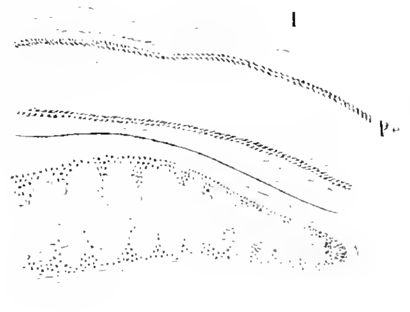
Fig. 4. *Carinina grata*, n. gen. et sp. The same, in a region where the gland-cells of the glandular stratum are all considerably reduced and the basement membrane contracted into waves. The nervous plexus is not indicated in this figure. Lettering as in fig. 3.

Fig. 5. *Carinina grata*, n. gen. et sp. A horizontal section through the point of insertion of the proboscis in the head. The cellular integument is coloured red. *M*, the musculature, chiefly longitudinal, from which fibres emerge to pass backwards into the musculature of the proboscis, the epithelium of which is marked *Pe*. Other radial fibres attach the rhynchodæum in the head, the cellular coating of which (*APe*) is thicker and more vacuolated than that of the proboscis. *Bl* (upper), blood-space in the head; *Bl* (lower), space of proboscidian sheath; *cf*, cephalic furrow.

Fig. 6. *Carinina grata*, n. gen. et sp. More enlarged figure of a transverse section of the body-musculature. Lettering as in fig. 3. Moreover, *ct*, hyaline gelatinous tissue between the muscular bundles, carrying nuclei. Other nuclei are detected in the centre of the muscle bundles. To the left of the layer *Cm* there is a faint indication of what is possibly a second internal layer of plexiform nerve-tissue.

Fig. 7. *Carinina grata*, n. gen. et sp. Enlarged figure of a transverse section of the lateral nerve-stem. *Nst*, the fibrous core with sparse nuclei; *Ngc*, the cellular investment of the stem, continued into *Nl*, the nerve plexus, all three still forming part of the deeper layers of the integument, which by the basement layer *B* (not passing over the nerve-stem) is separated from the subjacent muscular layers (*ec*); *Gi*, the deeper gland-cells of the integument. The nerve-trunk is attached by fibres binding it down to the muscular layers.

Fig. 8. *Carinina grata*, n. gen. et sp. The same in tangential section. Lettering as in the preceding figure. The attaching fibres are seen to be not continuous but arranged in closely set bundles. The integumentary gland-cells show different colours in the left and in the right half of the section; in the intervening region they are not developed; this would thus correspond to such a region as is represented in fig. 4 in longitudinal section.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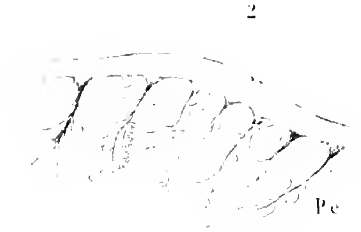
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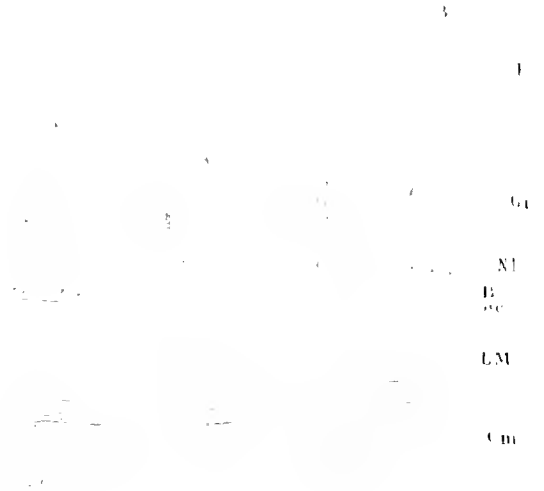
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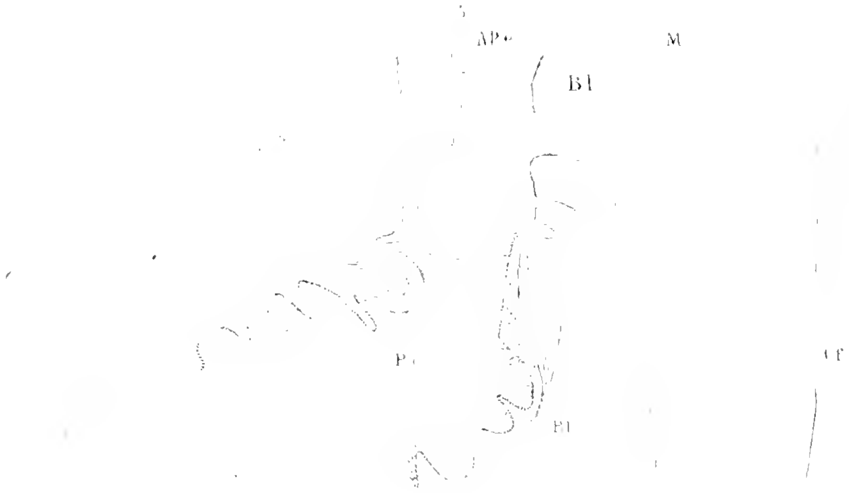
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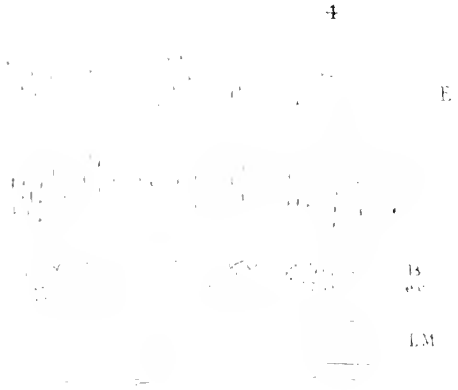
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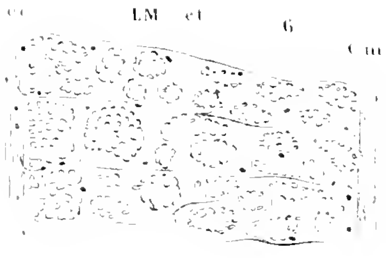
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CARININA

PLATE IV.

PLATE IV.

The basement membrane and the nephridial apparatus are on this plate indicated by a red tint.

Fig. 1. *Carinina grata*, n. gen. et sp. A longitudinal section through the body-wall at the point where the terminal duct of the nephridia (*Ne*) pierces it. *LM* and *ec*, muscular layers (see Pl. III. figs. 3, 4); *B*, basement membrane; *E*, cellular integument, with superficial and deeper gland-cells, separated by a layer of closely contiguous nuclei that belong to extremely elongated cells, placed perpendicularly to the surface.

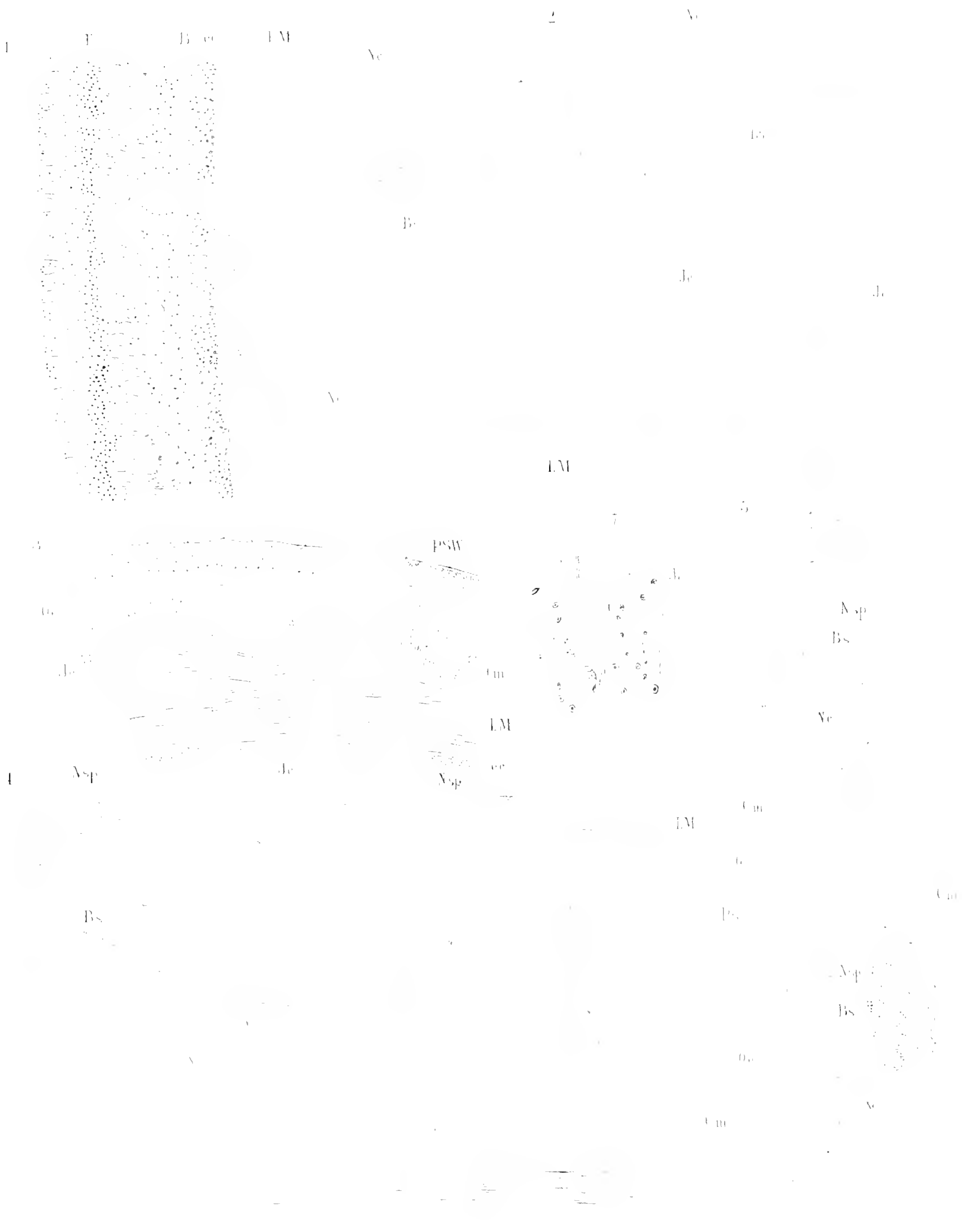
Fig 2. *Carinina grata*, n. gen. et sp. Section through a region where the nephridial canal (*Ne*) is still enclosed in the blood-space (*Bs*) in which a distinct cellular coating is observable, and which is separated from the intestinal cæca (*Je*) by the inner circular muscular layer (*cf.*, *Cm*, figs. 5, 6); *LM*, the outer longitudinal muscular layer.

Fig. 3. *Carinina grata*, n. gen. et sp. A longitudinal section through the œsophagus (*Oe*). *Je*, its ciliated epithelium directly applied upon the muscular layers *Cm*, *LM*, and *ec* (see Pl. III. fig. 3); *PSW*, the proboscidian sheath-wall, very thin, with the œsophageal epithelium below and its own nuclei above it. This fibrous wall is confluent superiorly with the layer of circular muscles *Cm* (*cf.* Pl. II. figs. 5, 9, 10).

Fig. 4. *Carinina grata*, n. gen. et sp. Section through the spongy and canalicular part of the nephridium (*Nsp*), and the region where it communicates with the principal nephridial duct *Ne*: *Bs*. *Je*, *LM*, and *Cm*, as in the preceding figures.

Figs. 5, 6. *Carinina grata*, n. gen. et sp. Transverse sections of the same system. The nephridia lie in the blood-spaces (*Bs*) which have their own cellular coating, and are partly enclosed in the circular muscular layer *Cm*. *Ps* and *Oe* indicate the respective situation of proboscidian sheath and œsophagus in relation to the nephridia; *Nsp* and *Ne* as in fig. 4.

Fig. 7. *Carinina grata*, n. gen. et sp. A portion of the œsophageal epithelium under higher power. *Je*, the granular epithelium cells; *c*, the cuticula with the cilia.


1
E
Bl. vc
LM
2
Nc
Nc
Bs
Bs
Je
Je
Nc
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3
PSW
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4
Nsp
Je
Nsp
Bs
5
7
Je
Nsp
Bs
Nc
Cm
LM
6
Ps
Cm
Nsp
Bs
Oe
Nc
Cm

CARINELLA

PLATE V.

PLATE V.

dcm,	Dorsal commissure.
vcm,	Ventral commissure.
SL,	Superior lobe separated into two lappets by a sulcus.
PL.	Posterior lobe.
cc,	Ciliated canal to the exterior.
LN,	Lateral nerve-stem, with fibrous core and cellular coating.
vn,	Innervation for the respiratory part of the œsophagus (n. vagus).
pn,	Innervation for the proboscis.
un,	Cephalic nerves.

Figs. 1–9. *Eupolia giardii*, n. sp. Reconstructions of the brain-lobes from a series of sections.

Figs 1, 2, 3, 4, 8 represent the outward aspect, viewed from different sides.

Figs. 5, 6, 7, 9 represent the fibrous core; the extension of the ganglion cells enclosing this core being indicated by faint outlines.

Figs. 1, 5. Seen from above.

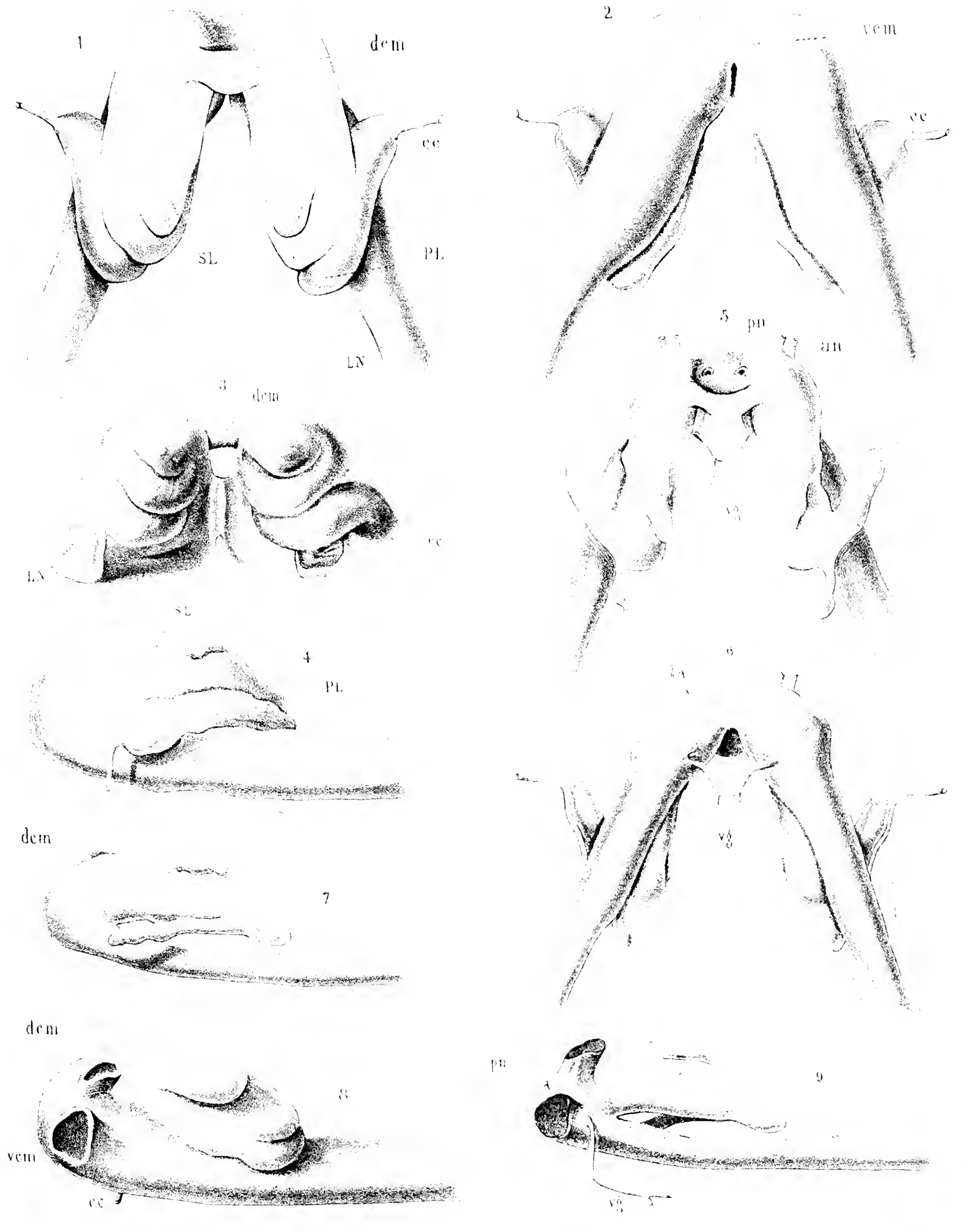
Figs. 2, 6. Seen from below.

Figs. 4, 7. Seen laterally and outwardly.

Fig. 3. Seen from behind.

Figs. 8, 9. Seen laterally and inwardly (after section of the commissure and removal of the left half).

In figs. 5 and 6 the course of the ciliated canal is specially indicated; in the former figure by a red outline.



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EUPOLIA

PLATE VI.

PLATE VI.

Fig. 1. *Carinina grata*, n. gen. et sp. The brain as situated in the deeper strata of the integument, seen in horizontal section (*cf.* woodcut fig. 5, p. 81). *Br*, *Br*, the anterior and the posterior brain-lobes. The inner fibrous core of these lobes white; in the anterior lobe traversed by radial fibres, in the posterior one containing the ciliated canal *cc*, that opens out in fig. 2 into the cephalic groove *Cg*; *Ngc*, the nerve-cells of the brain-lobes (stretching outwards as far as the red tint is applied in the figure); *gl.br*, glandular cells connected with them; *E*, the outer layer of the integument; *Gi*, the deeper one with gland-cells; *ec* and *LM*, muscular layers; *bs*, blood-lacuna between the œsophagus and the muscular body-wall; *Oe*, lumen, *Ie*, epithelium of œsophagus; *Nv*, branches of the so-called vagus nerve.

Figs. 2, 3. *Carinina grata*, n. gen. et sp. The posterior brain-lobe in following and preceding sections. Lettering as in fig. 1.

In all these three figures a marked increase of the nuclei in the immediate vicinity of the cephalic groove is particularly distinct.

Figs. 4–8. *Eupolia giardii*, n. sp. Transverse sections through different parts of the brain. Compare the figures on Pl. V. The fibrous core white, the nerve-cellular coating light red.

Fig. 4. Section through the lower commissure, just in front of the upper commissure. *Pr*, proboscis, the innervation of which, proceeding from the two brain-lobes, is noticed in this section (*cf.* Pl. V. figs. 5, 9).

Fig. 5. Section through both commissures, *i.e.*, a few sections further back.

Fig. 6. A few sections still further back, through the point of origin of the vagus nerve (*Nv*). *Prs*, anterior terminal portion of the proboscidian sheath.

Fig. 7. Section through superior, inferior and posterior lobe; the latter coated by the granular glandular cells *gl.br*, and with the ciliated canal *cc*.

Fig. 8. In the superior lobe the fibrous core has again subdivided, giving off an uppermost stem, the centre of the outwardly visible superior gyrus (*cf.* Pl. V. figs. 5, 7).

Fig. 9. *Eupolia giardii*, n. sp. Part of a transverse section through the œsophageal region. *cm* and *Ilm*, the circular and inner longitudinal muscular layer (β and α of Pl. XI. fig. 12); *Pl*, the nerve plexus just outside the former; *Nst*, the lateral nerve-stem in this plexus; *Prs*, the proboscidian sheath with very thin walls; *dv*, the dorsal blood-vessel, situated, as are a dozen of circumœsophageal lacunar spaces (that communicate with each other), in the gelatinous tissue between body-wall and intestinal wall. *Oe*, the lumen of the œsophagus; *Ie*. its ciliated epithelium; *oe.m*, its longitudinal and circular musculature; *nep*, nephridian tubes. The thin longitudinal nerve-stem above the proboscidian sheath has been omitted in this figure.

Fig. 10. *Eupolia giardii*, n. sp. A transverse section of the dorso-median portion of the body-wall at the furthest end of the body. *cm*, *ilm*, *Prs*, as in fig. 9. *olm*, outer longitudinal muscular layer (γ, Pl. XI.); *Bct*, the much folded primary basement layer; *g*, the deeper glandular layer of the integument; *ef*, the longitudinal and circular fibres of the same; *E*. the outer layer of the integument (*cf.* Pl. VII. fig. 5 and Pl. X. fig. 6); *bv*, dorsal blood-vessel.

Fig. 11. *Eupolia giardii*, n. sp. Transverse section through the posterior part of the proboscis, with internal epithelium (*Pre*), longitudinal muscle-fibres (*Lm*), and external flattened epithelium (*e*).

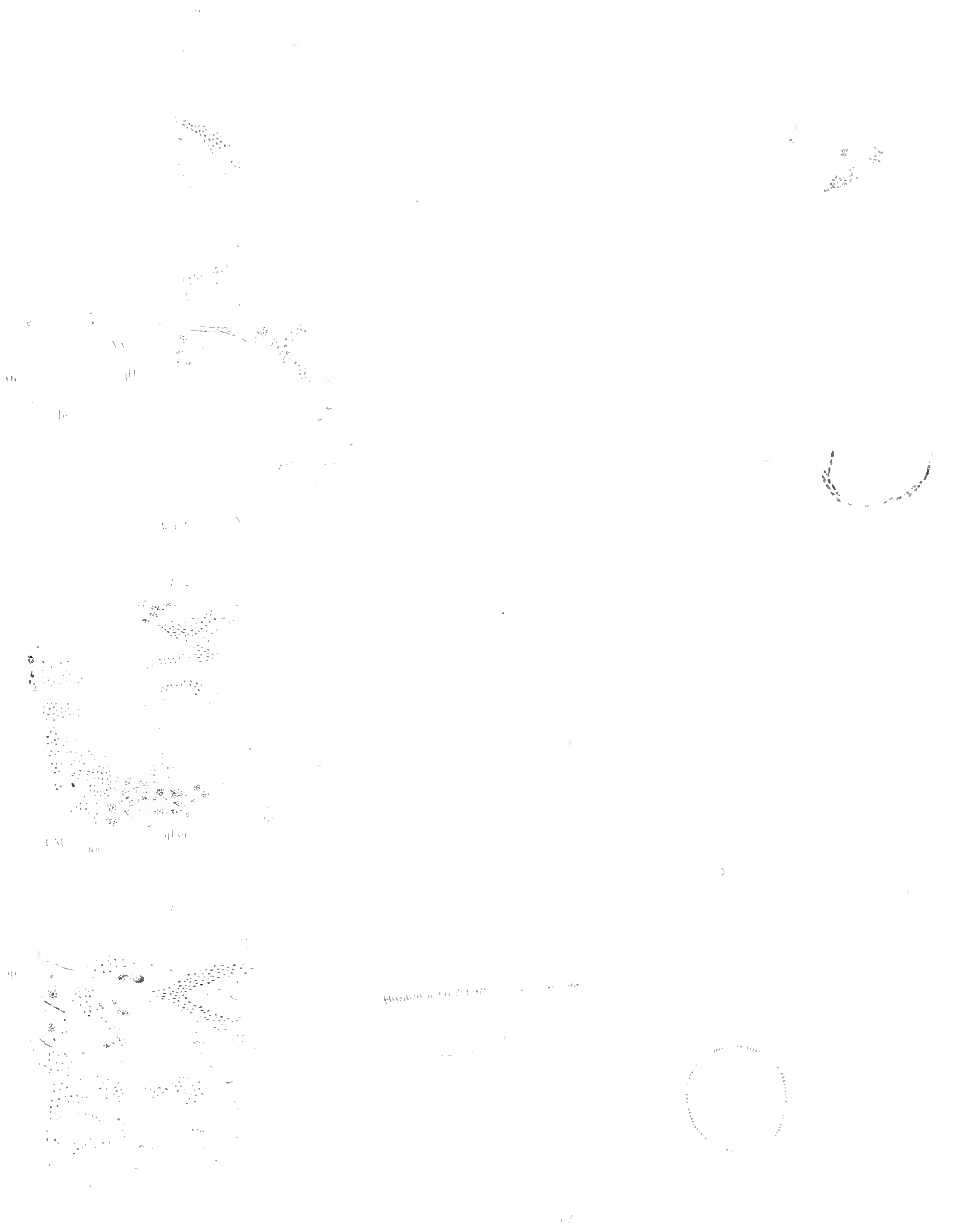


PLATE VII.

PLATE VII.

Fig. 1. *Eupolia australis*, n. sp. Diagram of a section through the posterior part of the œsophageal region. *Ps*, proboscidian sheath with underlying dorsal blood-vessel; *bs*, lateral blood-spaces, continued backwards, but not much further than the œsophageal region; *bv*, ventral blood-vessels; *Oe*, cavity of the œsophagus; *Nst*, lateral nerve-stems; *E*, outer integumentary layer.

Fig. 2. *Eupolia australis*, n. sp. Section of the body-wall about in the same region as the diagram of fig. 1, and in the vicinity of the left ventral blood-vessel. *E*, outer epithelial layer with unicellular glands; *B*, its (secondary) basement membrane; *ef*, scattered longitudinal and circular fibres beneath this; *gi*, subepithelial glandular layer; *olm*, outer longitudinal muscles, as yet very far from being a compact layer; *cm*, circular muscular layer; *ilm*, inner layer of longitudinal muscles; *ct*, cellular coating of the circumœsophageal blood-space. (Between *olm* and *gi* the reference letter *Bct*, indicating the primary basement tissue (*cf.* figs. 3, 5), should be inserted.

Fig. 3. *Eupolia australis*, n. sp. Section of body-wall of the same specimen, very much further back. Lettering as in fig. 2. Moreover, *Bct*, fibrous connective tissue (primary basement membrane) between *gi* and *olm*; *Je*, epithelium of the intestine; *bv*, left ventral blood-vessel. The outer longitudinal muscular layer is thinner, but at the same time much more compact than it was in the section of fig. 2. The blood-vessel and its surroundings, as well as the intestinal epithelium, are only represented diagrammatically.

Fig. 4. *Eupolia giardii*, n. sp. A transverse section through the dorso-median (medullary) nerve-stem (*dmN*). The nerve-fibres are transversely cut: the nuclei are distinct. *Nl.*, the nervous layer, continuous with the median stem; *olm*, outer longitudinal muscular layer with a considerable amount of gelatinous connective tissue (*ct*) between the separate bundles.

Fig. 5. *Eupolia giardii*, n. sp. Portion of a transverse section through the body-wall (*cf.* Pl. VI. fig. 9). Only a small portion of the very thick circular muscular layer *cm* is here represented. Lettering as in figs. 2 and 3. *Nst*, longitudinal nerve-stem; *Nep*, two radial ducts of the nephridia leading outwards, one of them opening to the exterior at *ne.o.* The outer longitudinal muscular layer is far from compact, the secretion of the sub-epithelial glands *gi* can be traced piercing the layers, *ef.*, *B* and *E*.

Fig. 6. *Eupolia nipponensis*, n. sp. The outer ciliated epithelium (*E*) and unicellular glands ("Schleimstabchenzellen") secreting their product (*u.g*) to the exterior, supported by the basement membrane B.

Fig. 7. *Eupolia australis*, n. sp. Longitudinal section in the posterior region of the body-wall, to show the generative ducts (*gd*) leading from the generative sacs (*gon*) outwards and piercing the muscular layers (*ilm* and *cm*) above the nerve-stem (*Nst*).

Fig. 8. *Eupolia giardii*, n. sp. The sub-anal nervous commissures in a horizontal section. *J*, cavity of intestine; *Je*, epithelium of the same; *N*, *N'*, the right and left longitudinal nerve-stem communicating by the transverse commissure; *E*, external epithelium.

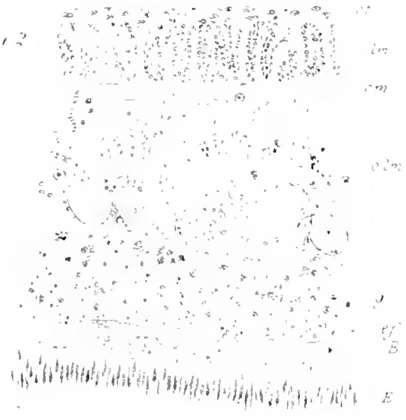
Fig. 9. *Eupolia delineata*, n. sp. Longitudinal section through the body-wall. Lettering as in figs. 2 and 3. *efp*, the external longitudinal and circular fibres that belong to the integument and have the pigment between them.

Fig. 10. *Eupolia delineata*, n. sp. Section of the proboscidian sheath. *Ps*, the cavity of the sheath lined by cells which are again encircled by a very attenuated circular layer; *bl*, blood-spaces outside of the proboscidian sheath; *cts*, strings of connective tissue by which the proboscidian sheath is suspended to the body-wall.

Fig. 11. *Eupolia nipponensis*, n. sp. Transverse section through the nervous layer (*Nl*). Nuclei are found imbedded in the nerve-substance and fibrous nerve strings stretch out from it radially at different points. *olm* and *cm*, the muscular layers.

Fig. 12. *Eupolia nipponensis*, n. sp. The œsophageal wall, in transverse section. *c.m.* and *ilm*, muscular layers of body-wall; *bs*, blood-space inside of these. The wall of the œsophagus is constituted of an inner ciliated epithelium *Je*, a basement layer B, and a thick layer of glandular cells *Jm*.

Fig. 2.



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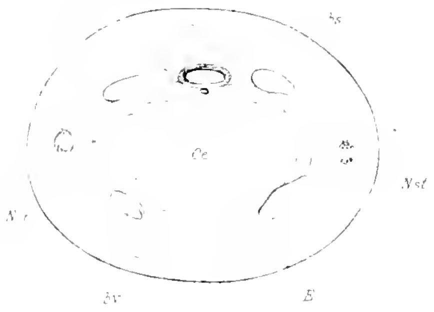

Fig. 3.

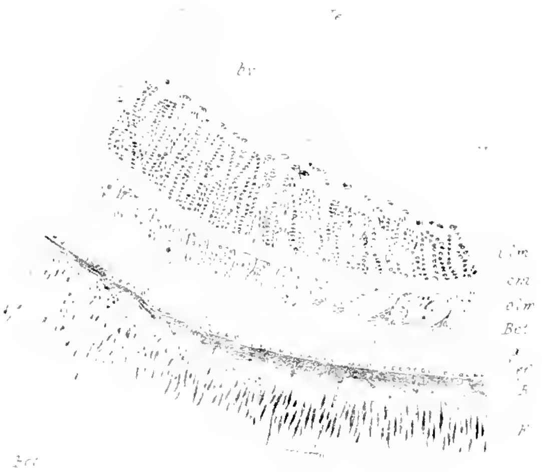

Fig. 4.

Fig. 5.

Fig. 6.

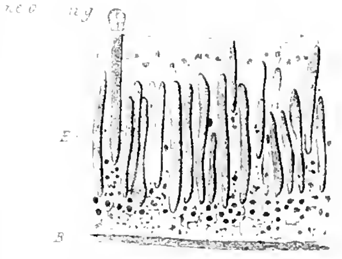

Fig. 7.

Fig. 9.

Fig. 10.

Fig. 8.

Fig. 11.

Fig. 12.

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EUPOLIA.

PLATE VIII.

PLATE VIII.

Figs. 1, 2. *Pterosoma plana*, Less. After Lesson, supposed by Moseley to represent a species of *Pelagonemertes*.

Fig. 1. Seen from above.
Fig. 2. Seen from below.

Fig. 3. *Pelagonemertes rollestoni*, H. N. M. A transverse section, supposed to be not quite vertical to the longitudinal body axis, so that to the right one of the digestive, to the left one of the generative cæca was touched in the section. *Ep*, external epithelial layer; *B*, basement membrane; *LM*, layer of longitudinal muscles; *J*, intestine and its branching diverticula; *N*, longitudinal nerve-stem; *bl*, two lateral blood-vessels; *Gc*, external opening of the generative cæcum; *P.S.C*, the cavity of the proboscidian sheath; *Ps*, the wall of that cavity. All the internal organs are surrounded by and imbedded in a wholly continuous gelatinous ground substance, in which a few cells and numerous fibres can be detected, and which has more strongly imbibed the staining reagent in the immediate vicinity of the different organs and tissues that traverse it.

Fig. 4. *Pelagonemertes rollestoni*, H. N. M. A horizontal aspect of the muscular layers of the body-wall, from a preparation made of the fresh animal by Professor Moseley. *lm*, the longitudinal muscles; *cm*, the sparse circular muscular fibres, external to the foregoing; *dr*, granular patches, eventually glandular structures; *ct*, the gelatinous connective tissue visible between the muscle fibres.

Fig. 5. *Pelagonemertes rollestoni*, H. N. M. A transverse section of what most probably corresponds to one of the granular patches of fig. 4, furnishing arguments for looking upon the latter as glandular. A central lumen (or fibre?), with nuclei surrounding it can be detected.

Fig. 6. *Pelagonemertes rollestoni*, H. N. M. The longitudinal nerve-stem *N*, in transverse section. A branch *n* gives off smaller nerve-twigs *n'* and *n''*. Nuclei are imbedded in the fibrous nerve substance. The gelatinous connective tissue is more deeply stained all round, and at *ff* has a distinctly fibrous appearance.

Fig. 7. *Pelagonemertes rollestoni*, H. N. M. The posterior region of the proboscis, in transverse section. *ll*, the longitudinal muscular fibres, externally invested by a basement membrane; *E*, the epithelium, of which no details could be made out.

Fig. 8. *Pelagonemertes rollestoni*, H. N. M. An empty genital cæcum, in transverse section. In the lower narrower part the epithelium is high and very distinct and a couple of epithelium-cells are becoming converted into ova, *ov*. *N*, the nerve-stem; *bl*, the blood-vessel; *Gc*, the empty cavity; *ctc*, connective tissue cells in the gelatinous ground-substance; *f*, fibrous tracks in the same.

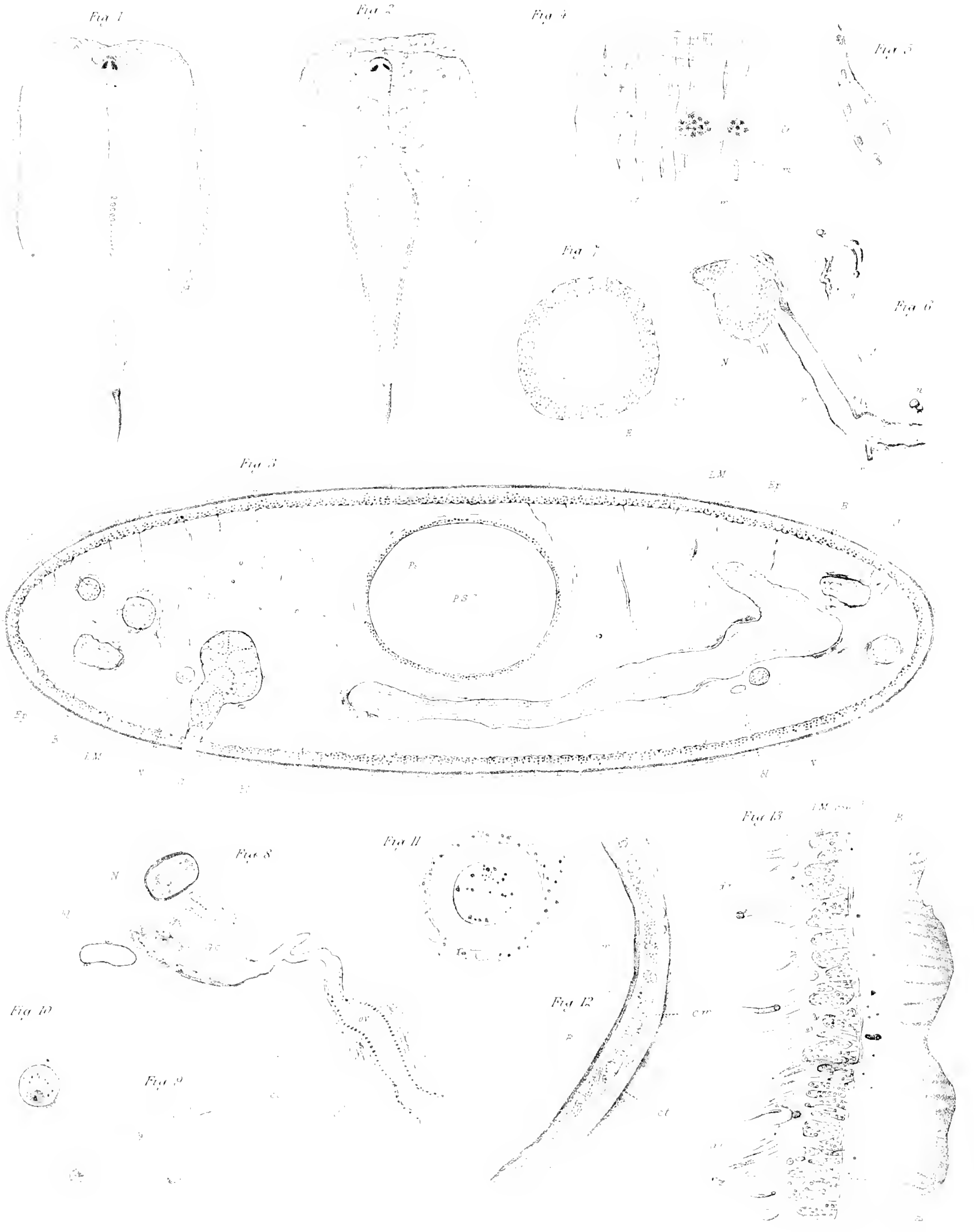
Fig. 9. *Pelagonemertes rollestoni*, H. N. M. Isolated transversely striated cells from the wall of the cavity, *Gc*, in fig. 8.

Fig. 10. *Pelagonemertes rollestoni*, H. N. M. A young ovum.

Fig. 11. *Pelagonemertes rollestoni*, H. N. M. A larger ovum, surrounded by its follicle cells (*cf.* fig. 3). No distinct nucleolus, but numerous chromatic granules inside the nucleus.

Fig. 12. *Pelagonemertes rollestoni*, H. N. M. Portion of the proboscidian sheath, in transverse section, under higher power. *B*, the inner homogeneous limiting membrane; *lm*, longitudinal; *cm*, circular muscular layer; *ct*, the outer sheet of the gelatinous tissue immediately applied against the muscles and again more deeply stained.

Fig. 13. *Pelagonemertes rollestoni*, H. N. M. Portion of the outer layers of the body-wall, under still higher power. The external cellular epithelium has not been represented. *B*, the thick basement membrane, below this epithelium, traversed radially by apparent glandular ducts (*cf.* figs. 4, 5); *B'*, a deeper portion of the same, less affected by the staining solution, and carrying connective tissue cells; *cm*, isolated circular, *LM*, thicker bundles of longitudinal muscular fibres; *dr*, probable glandular ducts in the gelatinous ground-substance penetrating through the muscles to the exterior.



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PELAGONEMERTES

PLATE IX.

PLATE IX.

J+B.	Integument and basement membrane
M.	Body musculature.
Gt.	Gelatinous tissue.
Prs.	Proboscidian sheath.
LN.	Lateral nerve-stem.
Int.	Intestine.
Gs.	Genital sacs, in many cases not yet in open communication with the exterior.
Prs.div.	Lateral diverticula of proboscidian sheath.
br.	Blood-vessel.

Figs. 1–6. Diagrams of different Hoplonemertea to elucidate (1) the relative extent of integument, muscular body-wall and internal gelatinous tissue; (2) the situation of the genital glands and their respective openings to the exterior.

Fig. 1. *Drepanophorus lankesteri*, n. sp. Middle of the body, diverticula of proboscidian sheath included in the section.

Fig. 2. *Drepanophorus lankesteri*, n. sp. Towards the extremity of the tail, between two pairs of diverticula of the proboscidian sheath.

Fig. 3. *Amphiporus marioni*, n. sp.

Fig. 4. *Amphiporus moseleyi*, n. sp. Numerous genital sacs, both dorsal and ventral, contained in one transverse section.

Fig. 5. *Drepanophorus serraticollis*, Hubr.

Fig. 6. *Drepanophorus serraticollis*, Hubr. In a further advanced stage of ripeness of the genital products (with distinct genital openings to the exterior); the diverticula of the proboscidian sheath not touched in this section. In all these sections the longitudinal blood-vessels are indicated, the median one below the proboscidian sheath, the lateral ones close to the lateral nerve-stems. In *Amphiporus moseleyi* the lateral nerve-stems are seen to lie *above*, in *Drepanophorus*, *below* the intestinal cæca.

Fig. 7. *Amphiporus moseleyi*, n. sp. Diagram of a horizontal section through the body. The intestine and its cæca are dark grey, the generative cæca light grey. The latter are seen to be very numerous and in no way regularly or metamerically arranged.

Fig. 8. *Amphiporus moseleyi*, n. sp. A specimen with flattened ventral surface. Natural size. A whitish line from the tip of the snout backwards along the lateral margin marks the exterior openings of the lateral glands (*cf.* Pl. XV. figs. 11, 12).

Fig. 9. *Amphiporus moseleyi*, n. sp. Head, seen from below. Longitudinal slit both for the intestine and the proboscis; terminal transverse sensory groove and lateral bent grooves into which the cavity of the posterior brain lobe opens.

Fig. 10. *Drepanophorus lankesteri*, n. sp. Diagram of the principal features of the nervous system. *B*, brain-lobes; *p.Br*, posterior brain-lobes (side organs) with their cavity opening to the exterior at *e.o*; *Ceph.ne*, numerous cephalic nerves to the tip of the head, the eyes, &c., only a few of them are here indicated in outline; *Prn*, nerves for innervation of the proboscis (they are more numerous than is here indicated); *Va*, outline of vagus nerve springing from the lower brain-lobes and running forwards towards the œsophagus. The latter passes beneath the brain-lobes and their double commissure, but above the ladder commissures (*Comm*), which metamerically unite the longitudinal nerve-stems (*LN*) below the intestine; *pe.ne*, peripheral nerves springing from these nerve-stems.

Fig. 11. *Amphiporus moseleyi*, n. sp. Stylet and accessory darts. *A* and *b*, *b'*, the central stylet and its two accessory sacs, in position; *b''*, bases of two accessory darts, viewed laterally (figure to the left), and perspectively (figure to the right).

AMPHIPORUS. DREPANOPHORUS.

PLATE X.

PLATE X.

Fig. 1. *Amphiporus marioni*, n. sp. Part of a transverse section through the œsophageal region, indicating the relative importance of the musculature with respect to the integument and the gelatinous tissue. *Prs*, proboscidian sheath in contracted state, the outline only partly worked up to show the interlacement of muscular fibres, the basement layer and the internal epithelium; *dr*, dorsal blood-vessel surrounded by gelatinous tissue, as is the proboscidian sheath, and *Oe*, the œsophagus with its cellular epithelium. Outside of this there is a layer of darker fusiform bodies, which are most probably unicellular parasitic organisms. *Gt*, the gelatinous tissue; α, the longitudinal, β, the circular muscular coat; at *ne*, a bundle of nerve-fibres spreads between α and β after having traversed the musculature between two of the larger bundles of α; *B*, thick basement membrane with only a few nuclei; *J*, integument; *LN*, longitudinal nerve: *Nep*, nephridial tubules; *Nep.d*, part of the communicating duct of the nephridia with the exterior; *inc*, peculiar crystalloid inclosures of a greenish colour, irregularly distributed in the gelatinous tissue.

Fig. 2. *Drepanophorus lankesteri*, n. sp. Part of a section through the tail end. *J*, the integument, with an outer layer of sense-cells and supporting cells; granular glands leading to the exterior, a layer of nuclei and one of deep lying cells with fainter nuclei; *B*, basement membrane with imbedded nuclei; α, the longitudinal, β, the circular muscular layer; *Gt*, the gelatinous tissue with nuclei and cells inclosed, certain of these being on their way of transformation into fibres; *LN*, longitudinal nerve-stem.

Fig. 3. *Amphiporus moseleyi*, n. sp. Horizontal section through the tip of the snout. *Pr*, proboscis and its musculature passing into and being the direct continuation of α, the longitudinal muscular layer; *Prs*, the proboscidian sheath: *Sp.Pr*, muscular arrangement in the wall of the rhynchodæum constituting a sphincter; *Rh*, external opening of the rhynchodæum, which is internally clothed by a layer of cells very gradually passing into the proboscidian epithelium, and externally into *J*, the integument; *B*, basement membrane; β, circular muscular layer, obliquely cut; *Gt*, gelatinous tissue; *Br*, *Br'*, left and right brain-lobes; *E*, eyes; *gls*, lateral glands, continued along both sides of the animal (*cf.* Pl. XV. figs. 11, 12).

Fig. 4. *Drepanophorus lankesteri*, n. sp. Proboscidian sheath with diverticula (*div.Prs*). *Prs.ep*, epithelium of the sheath, separated by folded basement tissue from the muscular wall.

Fig. 5. *Drepanophorus serraticollis*, Hubr. Proboscidian sheath with thicker muscular walls and thinner walled diverticula (*div. Prs.*).

Fig. 6. *Eupolia giardii*, n. sp. The boundary line between integument and body musculature. *Jdvl*, deeper layer of vacuolated cells of the integument; *B*, reduced and folded primary basement membrane; γ.*rl*, outer longitudinal muscular layer with large vacuolated cells and rare muscle fibres. The vacuolated cells have larger nuclei than those of the integument (*cf.* Pl. VII. fig. 5).

Fig. 7. *Cerebratulus* sp. inc. (*medullatus ?*). Transverse section of medio-dorsal region. *J*, integument; *b*, secondary basement membrane; γ, outer, α, inner longitudinal, β, circular muscular layer; *Prs.ep*, epithelium of the proboscidian sheath; *PrsN*, longitudinal nerve of proboscidian sheath; *ne*, nervous layer with median medullary thickening.

Figs. 8, 9. *Cerebratulus macroren*, n. sp. The proboscidian sheath wall and intestinal epithelium wholly (fig. 9) and half (fig. 8) distended by the proboscis. *dr*, dorsal blood-vessel (in fig. 8 still within the proboscidian sheath cavity); *Prs.ep*, the epithelium of the proboscidian sheath, supported by a homogeneous membrane. *b*, and surrounded by muscular layers *m.Prs*. *Oe.ep*, epithelium of the œsophagus.

Fig. 1

Fig. 4

Fig. 5

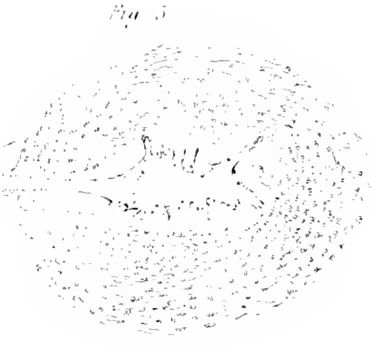


Fig. 6

Fig. 7

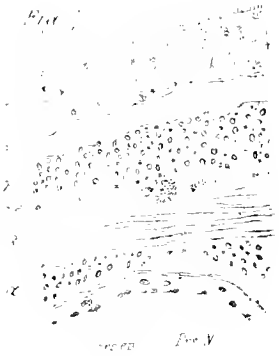


Fig. 8

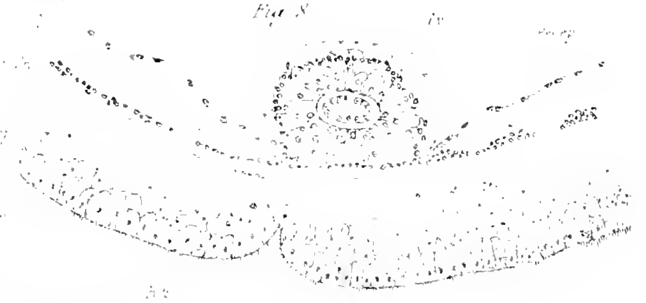


Fig. 2

Fig. 9

Fig. 3

Hubrecht u. de Groot del.

AMPHIPORUS. DREPANOPHORUS. EUPOLIA CEREBRATULUS

PLATE XI.

PLATE XI.

Diagrammatic figures to illustrate the situation of the dorso-median medullary nerve, and at the same time the arrangement of the different layers of the body-wall and their respective relation as to size, &c.

The twelve upper figures are supposed to be taken as transverse sections just above the proboscidian sheath, and are on purpose all reduced to the same scale, by which process the relative importance of the integumentary layer is clearly brought out.

The corresponding muscular layers are indicated by the same Greek letters—α is the most important longitudinal one, common to all; β, the circular; γ, the outer longitudinal; δ is a circular muscular layer characteristic of the Carinellidæ (figs. 1, 2, 3, 6, 13, and 14); it here forms the dorsal wall of the proboscidian sheath and at the same time it forms part of the body-wall in the anterior part of the body; in all the others it has become detached and has possibly developed into the outer wall of the proboscidian sheath, and as such is not indicated in figs. 5, 7–12. *J*, stands for the integument; *B*, for the primary basement membrane separating this from the muscles; *b*, for the secondary basement layer.

The plexus and medullary nerve are indicated by a yellow tint.

Fig. 1. *Carinina grata*, n. sp.

Fig. 2. *Carinina grata*, n. sp. More posteriorly.

Fig. 3. *Carinella.*

Fig. 4. *Carinella.* Further back in the region where the proboscidian sheath does not extend.

Fig. 5. *Cephalothrix.*

Fig. 6. *Carinoma armandi* (M'Int.), Oud. Here the proboscidian sheath nerve lies below the medullary nerve and is thicker than the latter.

Fig. 7. *Carinoma armandi* (M'Int.), Oud. Further backwards in the region where the proboscidian sheath does not extend.

Fig. 8. *Amphiporus* or *Drepanophorus.*

In figs. 9–12 the proboscidian sheath nerve is indicated and is seen to be less conspicuous than in *Carinoma.*

Fig. 9. *Cerebratulus corrugatus*, M'Int.

Fig. 10. *Cerebratulus medullatus*, n. sp. The deeper glandular layer of the integument has fused with the outer layer of longitudinal muscles, and the primary basement membrane has thus disappeared.

Fig. 11. *Cerebratulus macroren*, n. sp.

Fig. 12. *Eupolia giardii*, n. sp.

The figs. 13–17 have reference to transverse sections of the body-wall in the region of the lateral nerve-stem.

Fig. 13. *Carinella* (for *Carinina*, *cf.* Pl. III. fig. 7).

Fig. 14. *Carinoma armandi* (M'Int.), Oud.

Fig. 15. *Cephalothrix.*

Fig. 16. *Cerebratulus.*

Fig. 17. *Amphiporus.*

Fig. 1

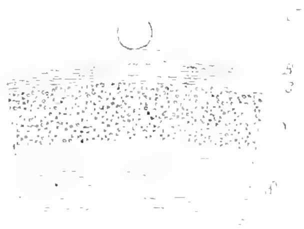


Fig. 2

CARINELLA

Fig. 3

Fig. 4

CARINELLA

Fig. 5

CEPHALOTHRIX

Fig. 6

Fig. 7

CARINOMA

Fig. 8

DREPANOPHORUS

Fig. 9

Fig. 10

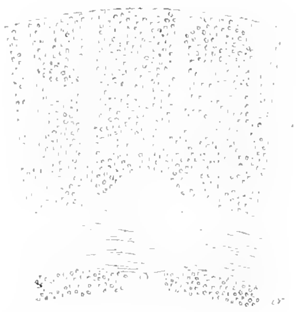
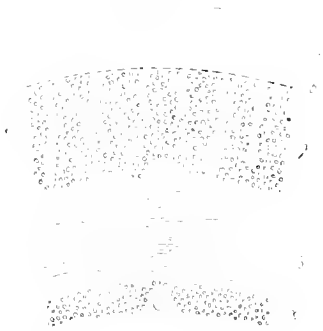
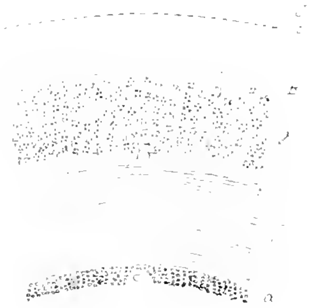


Fig. 11



CEREBRATULUS

Fig. 12.



EUPOLIA

Fig. 13

CARINELLA

Fig. 14

CARINOMA

Fig. 15

CEPHALOTHRIX

Fig. 16

CEREBRATULUS

Fig. 17

AMPHIPORUS

PLATE XII.

PLATE XII.

Fig. 1. *Cerebratulus macroren*, n. sp. Transverse section through a part of the brain-lobes of the New Zealand specimen. The medullary nerve (*m*) is still in connection with the brain-lobes (*bl*); *prs*, the proboscis, passing between the nervous ring formed by the brain-lobes and their commissures. Superiorly two bundles of longitudinal muscle-fibres are enclosed by the brain-tissue.

Fig. 2. *Cerebratulus macroren*, n. sp. Transverse section of the body-wall in the region of the lateral nerve-stem (Japanese specimen). $\alpha.\beta.\gamma$, the three muscular layers, the latter with the deeper integumentary glands embedded between the muscle-bundles (*cf.* Pl. XI. figs. 10, 11); *pl*, the nerve plexus; *b*, the secondary basement membrane with the thin layers of integumentary muscles just below it; ***J***, the cellular integument; *N*, the lateral nerve-stem, into the fibrous core of which part of the fibres of the plexus may be seen to be interwoven.

Fig. 3. *Cerebratulus corrugatus*, M'Int. Transverse section of the medullary nerve (*m*) at a point where a pair of transverse stems (*cf.* Pl. XIV. fig. 1) merge into it. *n*, these nerve-stems (being thickened tracts in the plexus, *pl*); *pf*, nerve fibres radially emerging from these tracts and having the significance of sensory or motor peripheral twigs; *ri*, radial fibres (not nervous) piercing the plexus (*cf.* Pl. XIII. figs. 3, 4, *rf*).

Fig. 4. *Cerebratulus corrugatus*, M'Int. Transverse section of the medullary nerve of another specimen. Lettering as in the foregoing figure.

Fig. 5. *Drepanophorus lankesteri*, n. sp. Transverse section of the lateral nerve stem (*N*), with two peripheral nerves, *pf*, springing from it. The fibres of the latter partly emerge from the ganglion cells, partly from the fibrous core of the lateral stem.

Fig. 6. *Drepanophorus serraticollis*, Hubr. A portion of a transverse section through the proboscis. *l.l′*, the longitudinal muscle-fibres, in two strata, between which lies the nerve-plexus *np*, of which *ln* is one of the longitudinal thickenings (nerve-stems); *o.c*, the outer; *i.c*, the inner layer of circular fibres; *b*, transparent basement tissue.

Fig. 7. *Cerebratulus macroren*, n. sp. Transverse section of the superior nervous connection between the two brain-lobes (Japanese specimen). Nerve cellular elements predominate in this region whence the medullary nerve is continued both backwards and forwards. *hl*, the homogeneous layer forming an investment to the nerve-tissue; *prs*, the proboscidian sheath in outline.

Fig. 8. *Cerebratulus macroren*, n. sp. A few sections further backwards. The medullary nerve *m* is here more distinct, its anterior continuation *m′* being on the point of coalescing with it. Lettering as in fig. 7. *pr*, outline of the proboscis; *Br*, fibrous core of the brain-lobe.

Fig 9. *Cerebratulus medullatus*, n. sp. Transverse section of the medullary nerve (*m*). *pl*, the plexus; β and α, the circular and longitudinal muscular layers; (inner circular muscular fibres are seen to form the outer layer of the proboscidian sheath); *prn*, the proboscidian sheath nerve, receiving delicate fibres from the medullary nerve and situated just above the proboscidian sheath musculature.

Fig. 10. *Cerebratulus medullatus*, n. sp. Integument and muscular body wall. Lettering as in fig. 2. *dgl*, the deeper glands of the integument enclosed in the musculature.

Fig. 1.

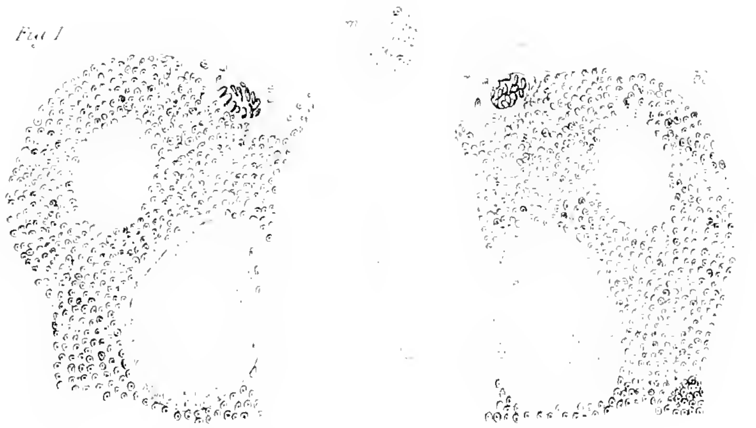


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 2.

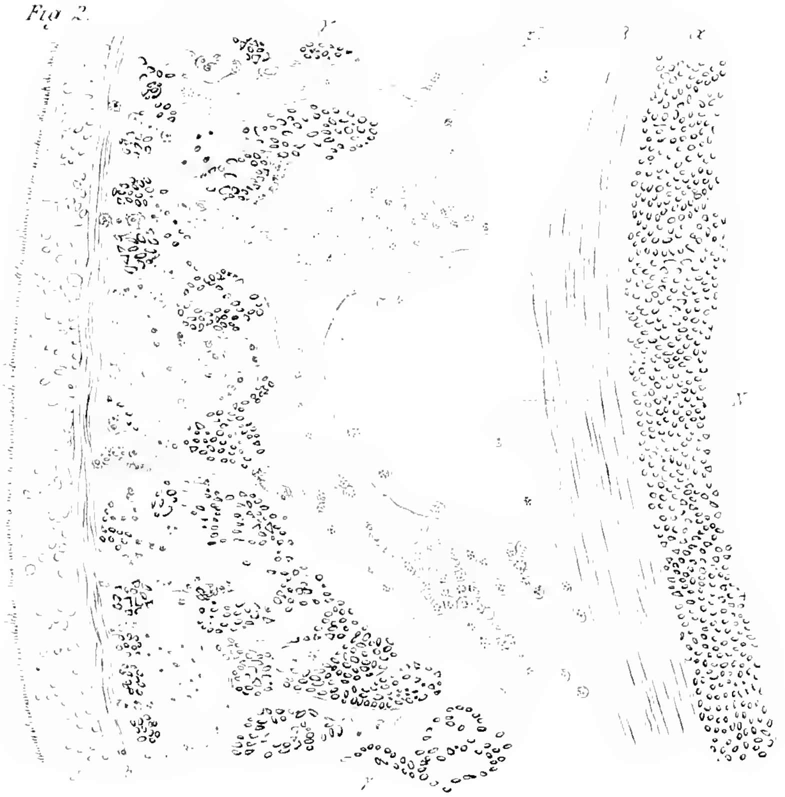


Fig. 7.

Fig. 9.

Fig. 8.

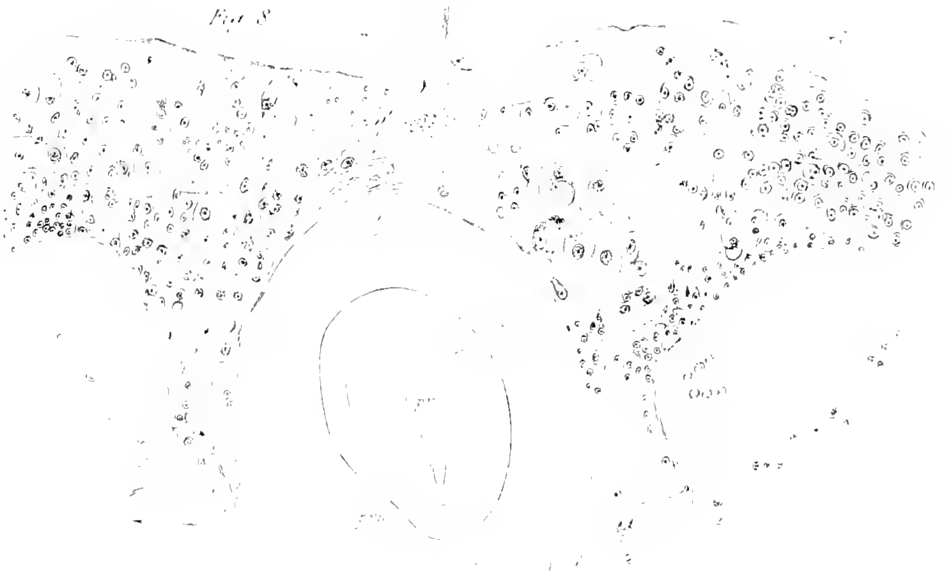


Fig. 10.

Hubrecht

CEREBRATULUS DREPANOPHORUS.

PLATE XIII.

PLATE XIII.

Fig. 1. *Cerebratulus corrugatus*, M'Int. Transverse section through part of the superior brain-lobes and dorsal brain commissure. Part of the fibrous core (*h*) is represented; its continuation into the fibres of the commissure (*f.co*) being distinctly noticed on the left side. On the right this connection is only visible a few sections further. The bulk of the brain-lobe is seen to consist of nerve-cells of different sizes (*n.cl*); from these a cephalic nerve (*cn*) is seen to emerge on the left, whereas this cellular coating is also continued over the commissure, and there forms the starting point (*m*) for the longitudinal dorso-median medullary nerve.

Fig. 2. *Cerebratulus corrugatus*, M'Int. Horizontal section of the same specimen through the medullary nerve *m*. In this section only a portion of the cylindrical nerve-plexus (*npl*), of which the medullary nerve is only the median thickening, is visible. The transverse nerve-tracts *tr.n*, paired and metamerical, being thicker than the plexus, are cut along a more considerable surface and thus stand out as separate nerves. The openings in the plexus give passage to radial, transverse, contractile fibres, as is specially indicated in fig. 4, *rf*.

Fig. 3. *Cerebratulus corrugatus*, M'Int. Portion of a horizontal section through the ventral extension of the nerve-plexus. *n*, the nerve-tissue of the plexus with nuclei of nerve-cells, and bundles of radial fibres *rf*. piercing it.

Fig. 4. *Cerebratulus corrugatus*, M'Int. Portion of the same section as fig. 2, more highly magnified. *n*, the tissue of the nerve-plexus with delicate fibres and distinct nuclei of nerve-cells, also visible in the medullary nerve *m*; *rf*, the bundles of radial, contractile fibres.

Fig. 5. *Cerebratulus corrugatus*, M'Int. Ventral view of the head and long mouth with rugose lips of large specimen. Natural size.

Fig. 6. *Cerebratulus corrugatus*, M'Int. Radial strip out of a transverse section in the œsophageal region. *Jsg*, the outer glandular layer of the integument (with "Schleimstäbchenzellen"): *b*, the secondary basement membrane below this; *Jlcm*, the longitudinal and circular muscle-fibres peculiar to the integument; *Jdg*, the deep glandular layer just below these; *B*, the primary basement membrane of the integument radially traversed by contractile fibres (*rf*) and nerve-bundles (*n*) going towards the integument; γ, the outer longitudinal muscles; *pl*, the nerve-plexus with fibres and cells, pierced by the radial contractile bundles *rf*; β, the circular muscular layer; α, the inner longitudinal muscular layer; *cos*, the circumœsophageal intercommunicating blood-lacunæ, clothed by a cellular endothelium; *mto*, the œsophageal musculature; *nr*, nerve-tissue in the œsophageal wall; *pap*, an œsophageal papilla with deeper glandular and superficial ciliated cell-layers.

Figs. 7, 8. *Cerebratulus macroren*, n. sp. Two sections through the principal nephridial duct of a specimen from Japan. Contracted (fig. 7) and distended (fig. 8).

Fig. 9. *Cerebratulus macroren*, n. sp. Anterior tubuliferous proliferation of the nephridia. α, β, muscular layers as in fig. 6; *Nep*, nephridian tubules applied against the wall of the circumœsophageal blood-lacuna; *Oe*, outline of œsophagus wall.

Hubr. et de Gr. del.

CEREBRATULUS

PLATE XIV.

PLATE XIV.

Fig. 1. *Cerebratulus angusticeps*, n. sp. The medullary nerve (*m*) and the transverse paired metamerical nerve-stems (*trn*). Drawn with the camera. 1 mm. on the same scale is indicated on the left of the figure.

Fig. 2. *Cerebralulus corrugatus*, M'Int. Transverse section of the lateral nerve-stem (*lN*) and body-wall. α, β, γ, the muscular layers; B, the primary basement membrane, and *J*, the integument in outline (*cf.* Pl. XIII. fig. 6); *rf*, radial fibres piercing the muscular layers; *n* and *pn*, nerve-tracts, of which one (*pn*) is seen to emerge directly from the lateral nerve-stem and to innervate the sensory layers of the integument; *npl*, nerve-plexus.

Fig. 3. *Cerebratulus corrugatus*, M'Int. Diagrammatic figure of a transverse section in the mouth-region to show the innervation of the œsophagus and blood-lacunæ. *OeE*, the œsophageal epithelium; *Prs*, the proboscidian sheath; *co.l*, the circumœsophageal blood-lacuna. In the nerve-plexus, which is indicated by a black line, *m* marks the medullary nerve, and *nl*, the lateral nerve-stems; *ri.n*, the visceral branches springing from the plexus; *n.va*, the vagus ramifications transversely cut and intermixed with the branches *vi.n*.

Fig. 4. *Cerebratulus corrugatus*, M'Int. Part of the same section as fig. 3, more considerably enlarged. Lettering as in fig. 3; *npl*, nerve-plexus; *rf*, radial, not nervous fibres; $\alpha.\beta.\gamma$, the muscular layers; *c.o.l*, the blood-lacunæ with cellular coating. The œsophageal epithelium (*oe.E*) is not represented in its whole thickness.

Fig. 5. *Cerebratulus parkeri*, n. sp. Diagram, drawn with camera, of the inferior brain-lobes, *Br*, and the vagus nerve (*va*) springing from them, the two stems being united by a series of transverse commissures *co* close to their origin. The brain-lobes merge into the lateral nerve-stem (*N*); the ventral metameric connections of the latter are indicated by dotted lines, *r.tr.n*, those of the brain-lobes being lettered *c.tr.n*; *Oe*, outline of the œsophageal epithelium.

Fig. 6. *Cerebratulus angusticeps*, n. sp. Horizontal section of the left upper and posterior brain-lobes (*Br* and *PBr*); *c.ol.*, *cl*, the free blood-lacuna between the brain, the proboscidian sheath, and the œsophagus, the boundaries of these two latter being only indicated by dark shading; α, β, muscular layers; *ln*, anterior portion of lateral nerve-stem, the ganglion cells of the cellular investment being here cut; *cc*, the outwardly directed portion of the ciliated canal inside the posterior brain-lobes; *cc′*, *cc″*, the deeper portion of the same being cut in two places, because of the S-shaped curve which this canal makes inside the brain-lobe. The relatively large size of the posterior brain-lobe, and the preponderance of fibrous nerve-tissue in the upper lobe, are indicated in this figure.

Figs. 7, 8. *Cerebratulus macroren*, n. sp. Two transverse sections (a few sections apart) through the posterior brain-lobe and its investment of large granular glandular cells (*g.cl*). *m*, the outer membranous investment of the lobe; *n.cl*, the ordinary ganglion cells with fibrous core in the centre of the lobe; *cc*, the ciliated canal with an epithelium of its own, more distinct in fig. 8 than in fig. 7.

Fig. 9. *Drepanophorus lankesteri*, n. sp. Part of a horizontal section through the upper brain-lobe, with interior fibrous core (*cf.*) and outer layer of ganglion cells, *n.cl*; a few of which are much larger (*nCl*).

Fig. 10. *Drepanophorus lankesteri*, n. sp. Part of a horizontal section through the posterior brain-lobe. *Bm*, the outer investment of the lobe; *n.cl*, the nerve-cells; *cc*, the ciliated canal with its epithelium; *gcl*, the granular glandular cells: the anterior ones pouring their contents into the lumen of the ciliated canal.

Fig. 11. *Cerebratulus macroren*, n. sp. Part of a transverse section through the head, showing the ciliated canal to the posterior brain-lobe in its course from that lobe (*PBr*) to the exterior. *gcl*, the granular glandular cells; *cc*, the lumen of the canal, coated by an epithelium of varied histological character as we pass outwards towards *E*, the external layer of the integument. At *gl*. a sort of ring-shaped cushion of peculiar cells may be said to embrace the canal (*cf.*, Pl. VI. figs. 1–3). Just behind this the epithelial cells are very closely set and provided with elongated nuclei, further backwards they are seen to pass without any sudden transition into those lining the canal, inside the brain-lobe.

Fig. 1

Fig. 5

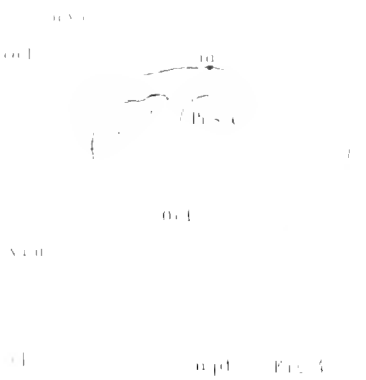


Fig. 2

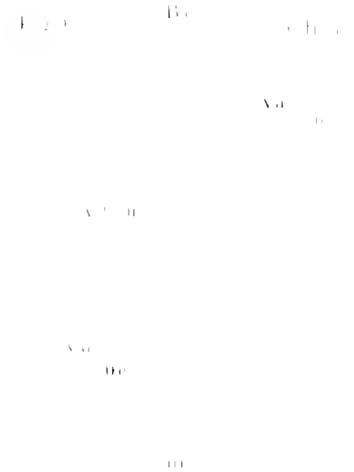


Fig. 6

Fig. 3

Fig. 7

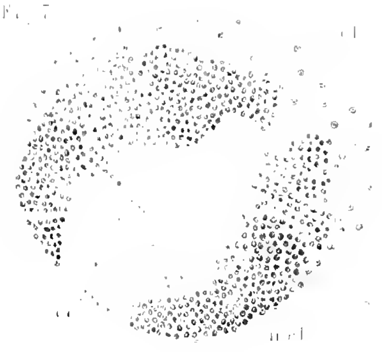


Fig. 8

Fig. 9

Fig. 11

Fig. 10

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CEREBRATULUS DREPANOPHORUS

PLATE XV.

PLATE XV.

Fig. 1. *Cerebratulus longifissus*, n. sp. Transverse section through the proboscidian sheath. α, the inner longitudinal muscular layer of the body wall; *pr.sn*, the proboscidian sheath nerve; *Pr.S*, the lumen of the proboscidian sheath; *e*, its inner epithelial lining; *b*, the homogeneous basement membrane of this epithelium, traversed by radial fibres and separating the aforesaid epithelium from the muscular layers (an inner longitudinal, and an outer circular) of the proboscidian sheath; *Gl*, the gelatinous tissue between the proboscidian sheath, the intestine and the body wall; *dr*, the dorsal blood-vessel.

Fig. 2. *Cerebratulus macroren*, n. sp. Transverse section of the proboscis. *b*, the ensheathing membrane; α' and γ', the two layers of longitudinal, β', the layer of circular muscular fibres, the latter connected crossways at two diametrically opposite points with the membrane *b*; *n.pl*, the nerve-plexus between β' and γ'; *E*, the very high inner epithelium with smaller (*c*) and larger (*C*) batteries of nematocysts.

Fig. 3. *Cerebratulus macroren*, n. sp. Transverse section of the proboscis much further backwards; the proboscis is thinner, the muscular fibres (α) only longitudinal, the epithelium (*E*) flattened, the nervous plexus replaced by two longitudinal nerve-stems *N*.

Fig. 4. *Cerebratulus angusticeps*, n. sp. Head. *a*, from below; *b*, side view.

Fig. 5. *Cerebratulus parkeri*, n. sp. Head. *a*, side view; *b*, from below. × 1½.

Fig. 6. *Cerebratulus* sp. inc. Two fragments from Japan. × 2. *a*, dorsal view; *b*, ventral view.

Fig. 7. *Cerebratulus* sp. inc. Transverse section of one of the fragments of fig. 6. *I*, the integument; α, β, and γ, the much reduced muscular layers; *N*, the lateral nerve-stems; *Int*, the intestinal canal and cæca, suspended in the gelatinous ground tissue *Gt*; *Gt'*, the same tissue expanded between the very sparse external fibres of the muscular layer γ; *PrS*, the proboscidian sheath; *bv*, the blood-vessels.

Fig. 8. *Cerebratulus* sp. inc. Lateral view of the head of another specimen from Japan (Kobe).

Fig. 9. *Cerebratulus longifissus*, n. sp. Longitudinal section of the tail end. *I*, the integument; *Int*, the intestinal epithelium; α, β, γ, the muscular layers; *npl*, the nerve plexus. This figure is meant to show the general aspect of the muscular layer α, more highly magnified in fig. 10.

Fig. 10. *Cerebratulus longifissus*, n. sp. The muscle-fibres of the layer α are seen to present a more considerable diameter in successive vertical planes, forming rings round the intestine and alternating with others in which this increase in diameter is not visible. Nuclei are also more numerous in the former portions than in the latter; *Ep*, the intestinal epithelium; *Gt*, the gelatinous tissue between this and the body musculature, with bundles of radial fibres.

Fig. 11. *Amphiporus moseleyi*, n. sp. Transverse section of the lateral region with glandular cavities (*gl*), arranged along the lateral line between the dorsal and ventral musculature α, piercing the circular muscular layer β at *c*, and suspended by the gelatinous tissue *gt*. *I*, integument; *B*, basement membrane.

Fig 12. *Amphiporus moseleyi*, n. sp. One of the glandular cæca, more considerably magnified, with granular epithelium and flattened nuclei exteriorly, the latter belonging to the surrounding gelatinous tissue.

Fig. 13. *Drepanophorus lankesteri*, n. sp. A section of similar glandular cæca in the dorso-median region of the head.

Fig. 14. *Amphiporus marioni*, n. sp. A very unripe generative cæcum, not yet opening to the exterior. β, Circular, α, longitudinal muscular layer. The cæcum reaches down into the gelatinous tissue, *gt*.

Fig. 15. *Amphiporus marioni*, n. sp. Ova in different stages of development.

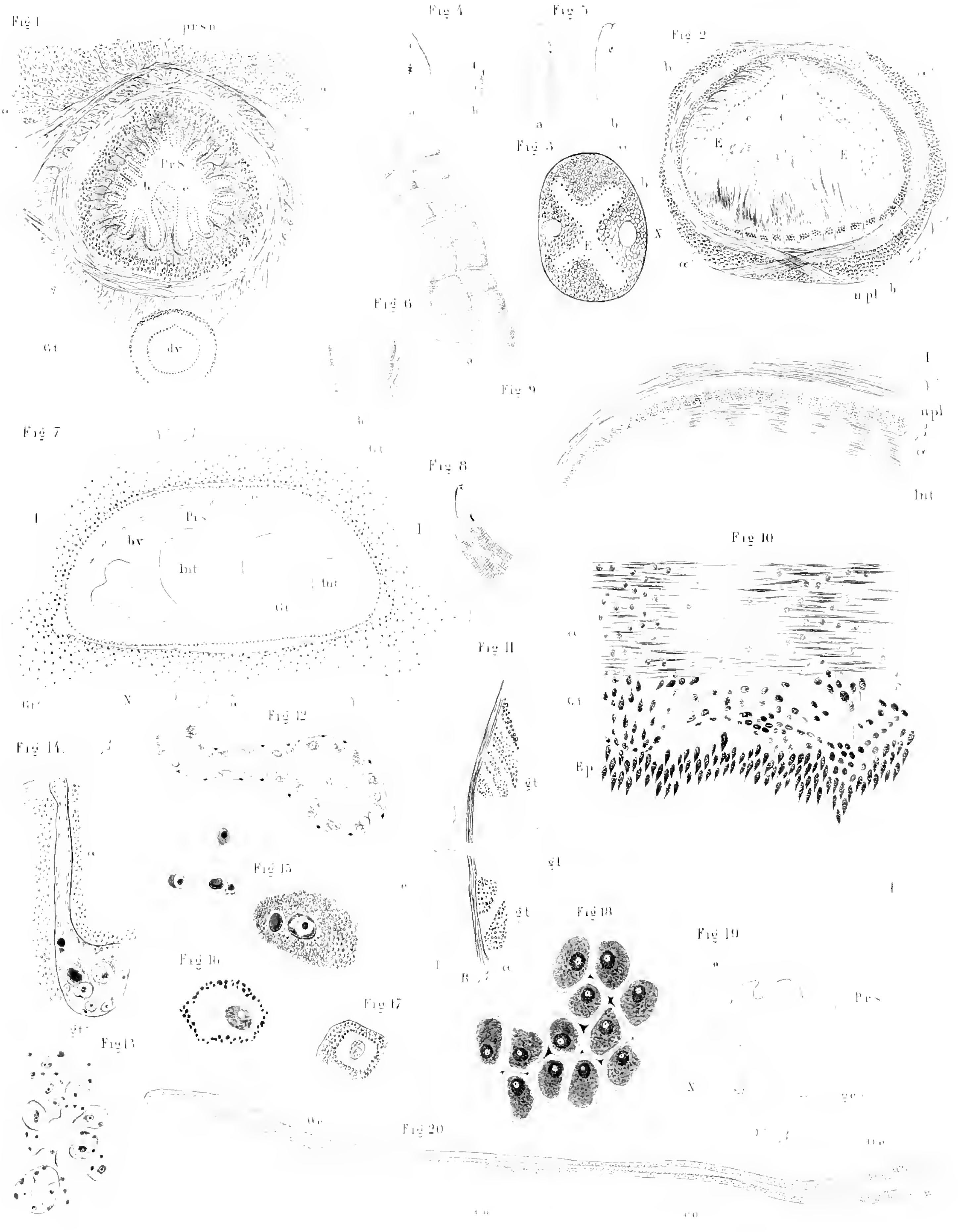
Fig. 16. *Cerebratulus parkeri*, n. sp. An ovum.

Fig. 17. *Drepanophorus serraticollis*, Hubr. An ovum.

Fig. 18. *Cerebratulus* sp. inc. A batch of ova from a ripe generative cæcum of a specimen from Station 321. The ova are surrounded by a hyaline membrane (which has erroneously been dotted by the lithographer) and pressed into polygonal shapes.

Fig. 19. *Cerebratulus macroren*, n. sp. Part of a transverse section, in outline. *Prs*, The cavity of the proboscidian sheath; *I*, integument; γ, β, the muscular layers; *N*, the longitudinal nerve-stem; *ge.c*, the generative cæcum; *o*, its exterior opening. The duct to this opening, where it pierces the layer γ, is considerably extended in bulk.

Fig. 20. *Amphiporus moseleyi*, n. sp. A longitudinal section through the greater part of the compressed œsophagus *Oe*, and subjacent intestinal cæca (*co*).



CEREBRATULUS AMPHIPORUS

PLATE XVI.

PLATE XVI.

Three diagrammatic figures for the comparison of the nerve system of the Nemertea, of the Vertebrata, and of the Cephalochorda.

Fig. 1. The chief points in the nervous system of the Nemertea. *ln*, *ln'*, the lateral nerve-stems with their anterior swellings, the brain-lobes, *Lg*. The latter are connected in front by a strong ring-shaped commissure, the former by much thinner but unmistakable commissures, *drr*, metamerically placed both dorsally and ventrally in a continuous plexus of nerve-tissue, that ensheathes the body. This plexus is no further indicated in the figure. It moreover carries a longitudinal medio-dorsal nerve-tract *m*, which is also continued forwards, in front of the brain commissure, with which it is connected. Into this medullary nerve *m* the transverse tracts *drr* converge. From the latter (*sensu strictiori* from the plexus) radial nerve twigs of sensory and motor significance can be traced both in centripetal and in centrifugal direction, but these are not indicated in the figure. Other similar nerve twigs, indicated by *ri.sy*, innervate in a similar way the wall of the œsophagus and of the blood-lacuna surrounding it (*cf.* Pl. XIV. figs. 3, 4). The innervation of the œsophageal wall is, moreover, brought about by a paired nerve, *r*, springing from the brain-lobes, and not strictly separate in its peripheral distribution from that of the nerves *ri.sy*. *cn*, nerves to the tip of the head; *M*, mouth.

Fig. 2. The chief points in the nervous system of the Vertebrata.

Instead of the medullary nerve we find here in the corresponding situation the medulla spinalis *m* and its anterior enlargement, the brain. The spinal nerves are represented in their primitive condition, *i.e.*, with the dorsal (sensory) roots *dr*, and the ventral (motor) roots *vr*, not yet connected into a spinal nerve of higher order. Anteriorly is represented the union of more than one metameric transverse root into a complex polymerous vagus nerve, *Vag*, motor and sensory branches of which are represented as innervating the branchial pouches of the fore gut (the latter not specially indicated in the figure). From the vagus ganglion also springs *ln*, the ramus lateralis nervi vagi or nervus lateralis; *ln'*, the left nervus lateralis. This nerve is continued forwards into other ganglionic swellings *Lg*, representing the series of ganglia of the cephalic nerves. The visceral branches springing from the dorsal roots and innervating vegetative organs are indicated by *ri.sy*; they are supposed not yet to have united into a longitudinal "sympathetic nerve." In front the region innervated by them overlaps and fuses with that of the intestinal branch *r*. of the vagus, and of other cephalic nerves. *M*, mouth.

Fig. 3. The chief points in the nervous system of *Amphioxus*.

The medulla spinalis *m* without any considerable anterior enlargement; *cn*, pairs of cephalic nerves; *dr*, dorsal roots; *vr*, ventral roots; the former springing from the medulla at a higher level than the latter. The dorsal roots are connected together in a plexiform arrangement; they give off visceral branches (*ri.sy*). *M*, mouth.


dvr
m
m
v
dr
vt
m
m
m'
v
m
Fig. 3
dr
ve
M