A

MONOGRAPH

OF THE

BRITISH ANNELIDS.

PART I.

THE NEMERTEANS.

BY

William Carmichael
W. C. McINTOSH,
M.D., F.R.S.E., F.L.S., ETC.

LONDON:
PRINTED FOR THE RAY SOCIETY.

MDCCCLXXIII.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

122

Dedicated

TO

THE MEMORY OF

R.,

THE AUTHOR'S ARTIST, FELLOW-OBSERVER,

AND

SISTER.

PREFACE.

The following fasciculus may be described as the First Part of a Monograph of the British Annelida, a department of native Zoology which more than any other required investigation, and whose neglected condition formed the author's chief inducement to attempt something for its improvement.

So little was known in this country with respect to the Nemerteans, while their structure and zoological affinities opened up so many interesting questions, that they could scarcely be passed over in such a treatise. Accordingly they have been examined—both in the living and preserved conditions—with as much care as the circumstances of the author admitted. He hopes, moreover, that the publication of the skilful and laborious coloured drawings of the external configuration of these worms (which were so kindly executed by her to whom the work is dedicated) will assist in rescuing them from the comparative obscurity in which they have hitherto been involved in this respect, both in Britain and on the Continent. He has endeavoured to render the other parts of the treatise worthy of the delicacy and beauty of these figures.

The species of the group are, on the whole, distinctly marked, so that comparatively little difficulty has been experienced in discriminating them; indeed, the chief variation in the majority is in colour, which, of course, obscures none of the essential characteristics.

Considerable additions may be expected to the list of species subsequently described (though the dredge has been used and the coast-line minutely examined at many points from the Shetland to the Channel Islands), and not a little new matter in regard to anatomy and development; but, with such a field as the whole Annelida before him, the author could not devote more time to the group. As no freshwater species has yet been found in this country, such a habitat especially should be diligently explored. The author, however, will be satisfied if he has paved the way for a more extensive and accurate study of these beautiful and interesting forms, whose life-histories and structure so amply reward investigation.

The Nemerteans have received so little attention from British zoologists that the author's list of contributions in this respect cannot but be small, and it is solely to the ceaseless care of a friend that he has been enabled to pursue the investigation with that completeness necessary for the elucidation of their anatomy and zoology, an investigation demanding an abundant and ever-ready supply of healthy living animals. Mr. Parfitt forwarded a few living specimens from the Devonshire coast, and Dr. Howden of Montrose, Prof. E. P. Wright of Dublin, Dr. Gray, Dr. Albert Günther, and the late Dr. Baird of the British Museum, Mr. G. S. Brady of Sunderland, Dr. Carrington of Eccles, Mr. J. F. Whiteaves of the Natural History Society, Montreal, and Prof. Dickie, Aberdeen, have also aided him by the communication of preserved examples or otherwise. Mr. Gwyn Jeffreys included some in his rich collections of Zetlandic Annelids, and, in conjunction with Dr. Carpenter and Prof. Wyville Thomson in the celebrated "Porcupine-" Expeditions of 1869 and 1870, he secured a most valuable collection of Annelids and Nemerteans, which was most courteously placed at the author's disposal by these gentlemen. To all these he begs to return his sincere thanks for their valued assistance, and specially to Dr. A. Günther, for his exertions in 1869. He has also to remember the many valuable hints in the microscopic department of this work received from the experienced hands of the late Dr. Fraser Thomson of Perth. Nor must he omit to acknowledge the steady encouragement given throughout these researches by Prof. G. Busk, whose cordial support at an early period was a source of the greatest satisfaction.

He has further to thank Professors De Quatrefages of Paris, E. Grube of Breslau, Kölliker of Wurzburg, and Van Beneden of Louvain, Mr. Alex. Agassiz of America, and Dr. Malmgren of Helsingfors, for their esteemed aid, by the communication of papers and otherwise. Two others, unfortunately, have since been early lost to science, viz. Professors W. Keferstein of Göttingen and E. Claparède of Geneva. The former did much to place Nemertean anatomy on a proper basis, and his conscientious original investigations gave promise of great advances in this as well as in other departments. M. Claparède, again, was, perhaps, the most distinguished investigator of the Invertebrates, especially the Annelida, of his time, and his splendid work both with pen and pencil will make his name enduring.

To the list of these losses he has now to add the lamented Dr. Baird, whose excellent labours amongst the collection of Annelida in the British Museum will long be remembered, no less than his genial and kindly aid to all interested in zoology.

For the delay in the issue of this portion of the work—a delay originating in the printing of the Plates—the author is not responsible, since it was ready at the end of 1869. He has to thank the Council of the Ray Society for their liberality in regard to the Plates, and Mr. Ford for his masterly touch in their execution.

MURTHLY; *September*, 1873.

CONTENTS.

The Ray Society was founded in the year 1844, for the publication of works on Zoology and Botany.

Each Person subscribing one Guinea is considered a Member of the Society, and is entitled to the Volume issued for the year to which the subscription relates.

Subscriptions become due on the 1st of January in each year.

The Back Volumes in Stock can be obtained on application to the Secretary, the Rev. Thos. Wiltshire, 25, Granville Park, Lewisham, London, S.E.

List of the Back Volumes in Stock, and the prices at which they can be obtained by Members.

	£	s.	d.
Reports on the progress of Zoology and Botany, translated by Messrs. Strickland, Macdonald, and Lankester	0	3	0
Reports and Papers on Botany, translated by Messrs. Busk, Macdonald, Henfrey, and Hudson	0	3	0
Reports on the progress of Zoology, translated by Busk, Tulk, and Haliday	0	3	0
Reports and Papers on Physiological and Geographical Botany, translated by A. Henfrey	0	3	0
Oken's Elements of Physio-Philosophy, translated by A. Tulk	0	3	0
Letters of John Ray	0	3	0
Botanical and Physiological Memoirs, including Braun on the Rejuvenescence in Nature, translated by A. Henfrey	0	5	0
A Synopsis of the British Naked-eyed Pulmograde Medusæ, by Prof. E. Forbes	0	10	0
The Oceanic Hydrozoa, by Prof. Huxley	0	15	0
The Germination, &c., of the Higher Cryptogamia, by Dr. Hofmeister, translated by F. Currey	0	15	0
The British Hemiptera Heteroptera, by Messrs. Douglas and Scott	0	15	0
The British Spongiadæ, Vol. II, by Dr. Bowerbank	0	15	0
The Miscellaneous Botanical Works of Robert Brown, Vols. I, II, and III. (The set, 30s.) each vol.	0	15	0
Recent Memoirs on the Cetacea, translated by W. H. Flower	0	15	0
Nitzek's Pterylography	0	15	0
The Shoulder-girdle and Sternum, by W. K. Parker	0	15	0
Vegetable Teratology, by Dr. Masters	0	15	0
A Monograph of the British Entomostraca, by Dr. Baird	1	0	0
A Monograph of the Recent Foraminifera of Great Britain, by Professor Williamson	1	0	0
Introduction to the Study of the Foraminifera, by Dr. Carpenter	1	0	0

	£	s.	d.
Bibliographia Zoologiæ et Geologiæ, by Prof. Agassiz, Vols. I, II, III, and IV (the set)	1	0	0
A Monograph of the Sub-class Cirripedia, by C. Darwin, Vols. I and II (the set)	1	0	0
A History of the Spiders of Great Britain and Ireland, by J. Blackwall, Parts I and II (the set)	2	2	0
(Part I, one guinea.)			
A Monograph of the British Nudibranchiate Mollusca, by Messrs. Alder and Hancock, Parts I, II, III, IV, V, VI, and VII (the set)	6	6	0
(Parts V, VI, and VII may be obtained at one guinea each.)			

The Reptiles of British India, by Dr. Günther, issued for the year 1863	1	1	0
A Monograph of the British Spongiadæ, by Dr. Bowerbank, Vol. I, issued for the year 1864	1	1	0
The British Hemiptera Heteroptera, by Messrs. Douglas and Scott. A Monograph of the British Spongiadæ, by Dr. Bowerbank, Vol. II, issued for the year 1865 (the set)	1	1	0
The Miscellaneous Botanical Works of Robert Brown, Vol. I. Recent Memoirs on the Cetacea, by Professors Eschricht, Reinhardt, and Lilljeborg, translated by W. H. Flower. Nitzch's Pterylography, issued for the year 1866 (the set)	1	1	0
The Miscellaneous Botanical Works of Robert Brown, Vol. II. The Shoulder-girdle and the Sternum, by W. K. Parker, issued for the year 1867 (the set)	1	1	0
The Miscellaneous Botanical Works of Robert Brown, Vol. III. Vegetable Teratology, by Dr. Masters, issued for the year 1868 (the set)	1	1	0
A Monograph of the Gymnoblastic Hydroids, by Dr. Allman, Part I, issued for the year 1869	1	1	0
A Monograph of the Gymnoblastic Hydroids, by Dr. Allman, Part II, issued for the year 1870	1	1	0
A Monograph of the Collembola and Thysanura, by Sir J. Lubbock, Bart., M.P., issued for the year 1871	1	1	0
A Monograph of the British Annelids, Part I, the Nemerteans, by Dr. McIntosh, issued for the year 1872	1	1	0

THE NEMERTEANS.

GENERAL REMARKS.

The Nemerteans are elongated non-bristled worms very plentifully distributed on all our coasts; yet, if not entirely overlooked, they have been generally regarded with a suspicion or aversion even more profound than that bestowed on the true Annelids; apparently, on the one hand, from their supposed resemblance to the forms that live parasitically in the bodies of the higher animals; and, on the other, from the intricacy of their structure, and the obscurity which shrouded their relations with surrounding groups. The appearance of the large species, indeed, has frequently given rise to feelings of superstitious wonder not unmixed with dread in the minds of the public; and some authors even have been more careful to indulge in the same vein in their narratives, than to increase our knowledge of the structure and economy of these interesting animals. They have especially received slight notice from British zoologists.

Cuvier first applied the name Nemertes[1] to designate the *Lineus marinus* of Montagu, and several subsequent writers have with propriety given the title Nemerteans to the Order, in which the name has been so long familiar. It is synonymous with the *Teretularia* of De Blainville, the *Annelosi Polici* of Delle Chiaje, the *Cestoidina* of Œrsted, the *Miocœla* of De Quatrefages, the *Aplocœla* of Blanchard, and the *Turbellaria Rhynchocœla* of others.

They have a soft, more or less elongated body, richly ciliated throughout, and the head is usually distinguished from the rest of the animal. The eye-specks and lateral slits (when present) are situated in the flattened snout.

The Nemerteans for the most part frequent the sea, though a few aberrant forms occur in fresh water. The British species, so far as yet observed, are all marine; one of them, moreover, having the semi-parasitic habit of a dweller in tubes attached to the hairs of the abdominal feet of female *Carcini*. This peculiarity amongst the Nemerteans was first noticed by Delle Chiaje,

[1] *Nemertes,* one of the sea-nymphs (Mediterranean as distinguished from the Oceanides)—daughters of Nereus and Doris.

who found his *Polia tetrophthalma* (a *Tetrastemma* with large eyes) in great abundance in the respiratory cavity of "*Ascidia mammellata.*" Leuckart and Pagenstecher also state that the former got at Nice a pale *Tetrastemma* in all the stages of egg, young and perfect animal—living parasitically in the body-cavity of *Phallusia mamillaris;* such, however, in all probability, being only a confirmation of the foregoing. A. Agassiz, again, found a species of *Planaria,* which he thinks identical with the *Planaria angulata* of Müller, on the under surface of the base of the tail in *Limulus.* This habit had also been observed in another *Planaria,* that frequents *Velella* in the Atlantic, by Lesson in his zoology of the 'Voyage autour du Monde sur la corvette La Coquille;' and by Schneider in the case of *Anoplodium parasita* (one of the Rhabdocœla), which inhabits *Holothuria tubulosa.* Further observations will in all likelihood lead to the discovery of parasitic species in the Medusæ. Such do not seem to be true parasites like the Entozoa, but may appropriately be grouped under the comprehensive title "Commensalisme," recently constituted by Prof. van Beneden—in an interesting lecture delivered before the Royal Belgian Academy. The animals included under this head do not prey upon the juices of their hosts; but, like the *Adamsia* attached to the shell containing the *Pagurus,* or the accompanying *Nereilepas,* they simply live together for their mutual comfort and convenience.

Comparatively few specimens, and these generally the largest forms, are to be found in our museums; and even such examples, if named at all, are often specifically confounded, the same animal, *e.g.*, *Lineus marinus,* being characterised by many names. In looking over such collections, indeed, one meets with a curious nomenclature; thus I have found a large *Sipunculus* labelled '*Serpentaria,*' a *Bipalium* '*Meckelia,*' an elongated *Synapta* and a *Tænia* respectively termed '*Lineus,*' and not a few distinguished by the ambiguous title of 'leech.' This confusion is partly due to the great changes that ensue on placing the animals in spirit. Specimens measuring feet or even yards in length shrink to short processes a few inches long, and the contour of the head is often indistinguishable on account of its retraction within the anterior portion of the body. Moreover, although the worm is in a manner preserved, it is generally unfit for dissection, and the colours frequently fade. While difficulties thus beset the investigator of specimens in museums, the obstacles to the satisfactory examination of the living forms are scarcely less perplexing; and though I would not fully endorse the description of Sir J. Dalyell, yet there is much truth in his observations:—"That many worms have no external prominences rising above the smoothness of their skin, or depressions sinking into it. That neither specks nor eyes, nor the position of the mouth can be discovered in the living specimens; that the student of animated nature cannot destroy his subject, and if perishing in his possession, it often goes so speedily to decay, that it is impossible, were he even a skilful anatomist, to avail himself of dissection."

The colours of many species of the group are of such beauty as to attract even the casual observer, while in this respect also they widely deviate from their supposed allies the parasitic worms. The richest purples appear on velvety skins of deep brown or black, each of the soft and mobile folds giving shades that vary in intensity and lustre. Bright yellow contrasts with dark brown; white with vermilion, brown and dull pink; while individual uniformity is characterised by such hues as rose-pink, white, green, yellow and olive, the gradations of colour in the various parts of a single specimen being so subtle that enthusiasm as well as skill is necessary in the artist who sets himself to the task of faithful delineation. Our indigenous species as a whole do not seem to be less brilliantly coloured than those of warmer climates, if we may judge from

Schmarda's plates, and the descriptions of other authors. Thus as regards beauty and variety of colouring the Nemerteans vie with any other group in the invertebrate series; while in the silky sheen and ever-changing iridescence of the active cilia, with which their whole bodies are covered, they surpass in some respects their gaily tinted superiors—the true Annelids.

The sexes of the Nermeteans do not appear to be distinguished by any peculiarity of shading, except where the ova or spermatozoa are observed through the translucent tissues of the adults. The reflections in regard to the bright colouring of these forms are somewhat cursorily treated by Mr. Darwin in his recent work.[1] These animals, he says, like many other invertebrates, "apparently stand too low in the scale for the individuals of either sex to exert any choice in selecting a partner, or for the individuals of the same sex to struggle in rivalry." The Nemerteans, however, are not devoid of sexual instincts, and the deposition of ova by a female, even at some distance from the male, gives rise to the immediate discharge of his special secretion. Thus Mr. Darwin would be furnished with the facts for stating that the best developed and most forward individuals would have most chance of securing numerous and healthy progeny. Their colours are not due to blood or bile, but are strictly skin-products, yet it would be as easy (or as difficult) to prove them advantageous to the creature as to demonstrate that the pale blood of some animals, the green or red of others, has been formed (as to colour) by natural or sexual selection. Indeed, there is scarcely a limit to the range of theory on such subjects, and it is hard to decide the one way or the other. The argument that the bright colours may be of use in leading their enemies to recognise them as unpalatable will scarcely suit, since fishes feed readily on some of the brightest. Neither can the proposition, available in the case of the soberly clad blind beetles, be of service, since some of the most gorgeously tinted (*e.g.*, *Carinella annulata* and *Lineus bilineatus*) are devoid of eyes; nor are the animals coloured in any special manner so as always to resemble their surroundings, as may be noticed in the olive-green and reddish varieties of *Lineus gesserensis*. *Tetrastemma candida*, on the other hand, assumes a greenish hue in certain instances amongst the littoral algæ, and the food of the translucent *Cephalothrix* has a wonderful effect in colouring the cells of its alimentary region. Some of the most vividly tinted species live in obscure crevices and creeks, where light can rarely enter. The bright reddish ova, again, of *Amphiporus pulcher*, which shine through the pellucid integuments, must render the female for a period a more conspicuous object than the male or undeveloped animal.

Though Prof. Grube's boatman saw the head of *Lineus marinus* 'shine,' and Viviani states that *Planaria retusa* is uniformly luminous, none of the British Nemerteans show this property.

There are, so far as at present known, thirty-one species of Nemerteans inhabiting the British Islands, and described in the following pages. The majority have been previously found; a few are new to Britain or to science.

[1] 'The Descent of Man,' &c.

HABITS.

In their native haunts these animals exhibit considerable diversity of habit. The majority, however, live under stones that lie on a muddy or sandy bottom, between tide-marks, either in pools or moist places, and, as scarcely a vestige of them is at any time seen unless a stone is upturned, their period of activity is probably during full tide. As their haunts indicate, they are fond of the shade, but I do not know that for this reason they are to be called, after De Quatrefages and others, nocturnal animals. Thus *Lineus marinus* is observed occasionally gliding amongst the seaweeds of a warm and sunny tide-pool.

Hundreds of some of the common forms, such as *Lineus gesserensis* and *Cephalothrix linearis*, may be found under a single stone, sometimes in tangled masses, amidst the muddy sand so common in such places. *Tetrastemma dorsalis* is gregarious, in vast flocks, on *Ceramium* and other algæ dredged in the Laminarian region; and *Prosorhochmus Claparedii* is frequently found in groups in fissures of the rocks near low-water mark in the Channel Islands. Leidy, in his 'Marine Invertebrata of Rhode Island and New Jersey,' also describes his *Nemertes socialis* as very abundant, often in masses, about the roots of corallines, between tides, at Point Judith. The larger and rarer forms occur either singly or in pairs, such as *Nemertes Neesii* and *Micrura*, which haunt the fissures of rocks near low-water mark. The great *Lineus marinus*, again, is often solitary, and the largest specimens almost always so, as well as limited in numbers—size, as in some of the higher forms of marine life, being thus inimical to profusion; and it may be noticed that a diligent search for a lengthened period in one locality diminishes very sensibly the number of large examples. Other Nemerteans frequent the coralline ground or its neighbourhood, such as *Micrura purpurea*, *Cerebratulus angulatus*, *Amphiporus pulcher*, and *A. spectabilis*, and they are partial to empty bivalve shells. Stones placed near the verge of low water, and covered with a profusion of algous and zoophytic life, furnish numerous specimens of the small *Tetrastemmæ*, which apparently delight to crawl amidst the roots and branches, no doubt attracted by the abundance of the other animal organisms that like themselves seek shelter and safety in these miniature forests. One of the best modes of collecting such small forms is to chip off at the proper season—for their abundance is probably periodic—shelving fragments of rock, and carry them home for immersion in shallow vessels of sea-water, when the worms leave their retreats and crawl to the water-line of the basin, after the manner of *Rissoæ*, *Skeneæ*, and other small Mollusca. The same may bé said of the roots of the tangles dragged from the rocks near or beneath low-water mark, such treatment being often the only safe mode of procuring perfect specimens of *Carinella annulata*, *Nemertes Neesii*, and *N. gracilis*, which generally interlace their lengthened bodies with the radicles. No richer ground for Nemerteans of rare size and beauty probably exists than the intricate roots of the vast tangles that envelop the muddy masses of horse-mussels in Bressay Sound, where Forbes and Jeffreys have each done such good work by aid of the old drag of the Zetlandic fishermen. Colonies composed of examples of different species, such as *Lineus marinus*, *L. gesserensis*, *Micrura fasciolata*, *M. purpurea*, *Nemertes Neesii*, and *Amphiporus pulcher*, are occasionally met with in the same root; while the hollows of the rough roots of *Laminaria bulbosa* give shelter to select pairs or solitary individuals.

Empty limpet-shells that adhere to the under surface of stones in tidal pools are also favourite lurking places for these animals. Although many of the smaller forms fashion gelatinous or membranous tubes with facility on sea-weeds and stones, one British species alone may be said to inhabit a tube or burrow not secreted by itself, viz. *Borlasia Elisabethæ*, which was found at Herm in a pit or burrow of clay; and in this, as in other respects, the species is peculiar. A foreign example, the *Stimpsonia aurantiaca* of Girard, is also stated to dwell in vertical tubes in sand, near Fort Johnston, Carolina.

The group, as a whole, is composed of animals by no means inactive, for they glide swiftly about in their native sites, only their length sometimes proves a barrier to their rapid disappearance from a particular spot. Crustaceans, starfishes, and mollusks, indeed, are but clumsy athletes when compared with the Nemerteans, whose bodies, deprived of all external protection, covered with cilia and endowed with exquisite sensibility, seem the very essence of mobility. On a solid surface, the chief mode of progression is by crawling, the body being thrown into a number of minute undulations, or else rendered more boldly moniliform by evident waves, which pass from the snout backwards. Some of the more active small species, again, such as *Tetrastemma candida*, frequently glide over the surface of glass so smoothly that scarce a wrinkle is noticed in the soft outline of their bodies, which, for the time, seem to be propelled by an invisible agency. In progression, the body is extended in a rectilinear manner, or else thrown into one or more graceful curves; while the snout is closely applied to the surface, or occasionally rolled from side to side. If a Nemertean, for example, *Amphiporus lactifloreus* or *Lineus gesserensis*, is raised from the surface on which it crawls, it will generally be observed that it clings most pertinaciously by the anterior end; indeed, it would appear that the lips exercise a kind of sucker-action, or, at least, that the under surface of the flattened snout does so. The bodies of several of the elongated forms resemble a semifluid yet coherent substance that can be drawn through any aperture, bent round any angle, and looped, coiled, or twisted in the most elaborate manner. In the more slender species, such as *Cephalothrix linearis*, the mobility greatly resembles that of the tentacular processes of the *Terebellæ*, and I have been puzzled at least once, on lifting stones and sea-weeds from the dredge and placing them in water, by the independent and Nemertean motions of the spotted tentacles of *T. nebulosa*, the owner of which was for the time invisible. In the same species the living animals in confinement often group themselves into rounded masses, which become veritable Gorgon's heads when the constituent members push forth their struggling snouts. The larger kinds also, such as *Nemertes Neesii* and *N. gracilis*, follow a similar habit; and, when the water is changed, it is an interesting sight to watch the heads of the individuals slowly emerging, softly and with ease, from the apparently inextricable coils. In few other groups of animals can such extreme conditions ensue between contraction and extension, and this not by the agency of sea-water, but by the extraordinary shrinking of the muscular substance, and the mobility of the other tissues of the animal. Specimens, measuring only a few inches in contraction, stretch with ease to the length of several feet; and irritants cause a large *Lineus marinus*, several yards in length, to shrink without injury into as many inches, while shorter forms become quite baccate. If a large example of the last-named Nemertean be held over spirit, the body seems to disappear swiftly on touching the liquid, and the hand with the shrunken mass rapidly approaches the surface. On viewing the motions of these animals, the observer will often be forcibly reminded of the graphic descriptions of the arms of *Pleurobrachia*, given by the elder Agassiz.

Like many of the true Annelids they also progress by floating on the surface of the water, either crawling up the side of the vessel, and thereafter pushing their snouts outwards from the water-line; or, if the water is shallow, raising their heads upwards from the bottom and gradually extending their snake-like bodies along the surface. As in the case of the Nudibranchiate Mollusca, a track of mucus is constantly left behind them in this position, and in the same manner they can be suspended by it. So abundant, indeed, is this mucus, that in jars containing numerous vigorous specimens of *Lineus gesserensis* a perfect gelatinous mesh-work is formed near the surface of the water, and even throughout the entire vessel. I had carefully tested by personal observation the correctness of the explanation given by Messrs. Alder and Hancock of the *modus operandi* by which the Nudibranchs crawl on the surface of the water, and the same explanation is very evidently applicable to this class. The adhesion of the body to the mucus gives the animal sufficient purchase for the use of its facile muscles, for it need scarcely be mentioned that the water has no influence in lessening the attachment. Hence the remark of M. de Quatrefages, that *Nemertes* glides through the water by means of excessively fine vibratile cilia, which are protruded from every part of the surface of the body, cannot meet with our support. When anxious to view the ventral aspect to advantage, no difficulty has been experienced in making many thus float on the surface of the water in the shallow trough of a large dissecting microscope, for by constantly irritating the animals in their endeavours to crawl along the bottom of the vessel, and arresting their progress, they at last pushed their snouts upwards, and sought refuge by this mode of progression.

While possessing the power of crawling and floating just mentioned, some species also swim freely through the water, and this habit in Britain is especially characteristic of the forms which inhabit deep water; indeed, I am not at present aware that littoral species exhibit it in any degree, though there is nothing inimical in their conformation. This habit has been noticed in the *Cerebratulus marginatus* of Nardo, the *Meckelia aurantiaca* of Grube, and by M. de Quatrefages, in his *Polia bembix*, dredged off the coast of Sicily. Four British species, as far as at present known, show this mode of progression, viz. *Amphiporus spectabilis*, *A. pulcher*, *Micrura fusca*, and *Cerebratulus angulatus*. When irritated, each throws itself on its edge, and by alternate lateral strokes of the tail propels itself rapidly through the water with a serpentiform wriggle. Thus, their mode of swimming closely resembles that of the freshwater *Nephelis*, and differs from the horizontal flapping of their allies, the Planariæ, which M. Dugès compares to the motion of the Rays. The British species above noted are characterised by their somewhat short and broad form, and especially by the production of the lateral margins into a thin edge throughout the greater part of the body.

Many of the Nemerteans, as M. de Quatrefages mentions, are very hardy in confinement, if the observer is at all experienced in the management of such animals. It is not by the well-calculated adaptation of plant to animal life, of nicely balanced conditions supposed to be favourable to the healthy continuance of marine existence in these artificial states, that the experiment is always successful. Pure sea-water in clean glass vessels, and, in some instances, a clean shell or empty *Balanus*, with a little sand or gravel on the bottom, constitute the most suitable aquaria. Unless the vessel is large, only one or two examples should be placed in each, and this is a point of great importance; indeed, in the case of rare or valuable specimens, solitary confinement has generally been resorted to as most advantageous. I have thus been enabled to keep alive at a great distance from the sea-coast numerous individuals of *Lineus marinus*, *L.*

gesserensis, *L. sanguineus*, *Amphiporus lactifloreus*, *Micrura purpurea*, *M. fasciolata*, and others, as well as to observe various interesting phases in their development. The vessels were always placed in a cool, and, if possible, in a darkened position, in accordance with the habits of the animals in their native sites; but the sea-water was not changed more frequently than four or five times a year, and in some cases not at all. Such confinement generally blanched the snout of *Lineus marinus*, so as to render the groups of eyes visible. The pallor of the upper and under surfaces of the snout in this species is peculiar, for the other parts of the animal are not affected. It occurs chiefly in the region of the cephalic sacs, across the entire breadth of the snout, and extends forward at the margins to the tip; the pigment of the centre of the snout anteriorly, both dorsally and ventrally, and the reddish hue in the region of the cephalic pits remain. I have kept this species, indeed, so long that the snout has become completely etiolated, with the exception of the eye-specks and the reddish coloration of the cephalic fissures. Moreover, throughout an inch of the anterior part of the body, the ventral surface had assumed a pale pink colour, and the six dark stripes on the dorsum were separated by a ground-colour of the same pale hue, which, besides, here and there interrupted the longitudinal dark bands. In the instances, again, of *Amphiporus lactifloreus* and the pale *Tetrastemmæ*, the opacity of the cutaneous textures is considerably increased; and as the two latter are generally best adapted for the investigation of certain minute details, it always became necessary to send to the rocks for a fresh supply. This opacity in the pale species is due to an increase of yellowish colouring matter in the cutaneous cells, and the deposition of brownish-red pigment, a change probably arising from a more frequent exposure to the sun's rays. In some specimens of *A. lactifloreus* under these circumstances, a general augmentation also occurs in the reddish pigment of the ganglia and anterior portions of the lateral nerves. A similar alteration ensues in other species, such as *Carinella annulata* and *Lineus bilineatus*, the former changing from pale brick-red to deep brownish red, and the latter from pale-pinkish buff to brown, thus intensifying the contrast with the pure white lines present in each case. This variety of tint, from exposure or seclusion, likewise occurs in their native haunts. Thus, for example, specimens of *Nemertes Neesii*, from a chink in the Gouliot Caves of Sark, have a much paler aspect than those from an ordinary tidal pool. The rule, however, has many exceptions, for in the same caves very dark olive specimens of *Lineus gesserensis* are found, while a variety of a pale reddish hue lives under stones beneath the open sky at the mouth of one of them. After protracted confinement without food, the longer forms generally lie coiled in an intricate mass on the bottom of the vessel, or, if only moderately elongated like *Micrura*, rest as a double band, and their bodies diminish in bulk to a very great degree. Under the same conditions the smaller species, such as *Tetrastemma* and *Prosorhochmus*, are often found at the margin of the water, and some having receded too far from their element become dried on the side of the jar. The latter accident especially occurs amongst groups of recently captured specimens, which have not yet attained the experience necessary for their preservation in this artificial habitat. Some sustain life under almost complete abstinence for very long periods, such as a year or eighteen months, their bodies being apparently supported by the slow absorption of their own tissues, so that, as before mentioned, their size is greatly reduced. There is, indeed, no structure in the bodies of the majority that is not capable of such change, and thus decrease, in every respect, is easily attained. I have not sufficient facts to enable me to make generalisations on the subject of their longevity; but the larger Nemerteans, *e. g. Lineus marinus*, *L. gesserensis*, and *L. sanguineus* live for several years, even under very unfavourable circumstances, in confinement. With ordinary care, also, they can be carried alive from remote parts of the country, as from the Channel Islands to Scotland, and from Shetland, without the loss of a single example of any of the species.

If, therefore, animals so large live for a protracted period in very limited supplies of salt water without a trace of food, our wonder is diminished at the apparent paucity of nourishment in the abysses of the Atlantic for the sustenance of the Foraminifera and other minute organisms mentioned by Dr. Carpenter, since, putting aside for the moment the dissolving jellies and ciliated young of certain of their neighbours, they have free access to the trackless ocean and all its contained organisms.

Under certain irritants, as, for instance, great impurity of the water in the case of recently captured animals, the common *Lineus gesserensis* turns itself inside out, so that the inner surface of the digestive chamber can be viewed without dissection. This also occasionally occurs on placing it in alcohol. The extreme shrinking of *Lineus marinus* on immersion in spirit is also sometimes due to a literal doubling of its body, one fold of which is thrust within the other, the outer being in its normal position, but the inner having its alimentary surface external. *Cephalothrix linearis* is killed by fresh water in a few minutes, the body being swollen by contraction and contorted. *Amphiporus lactifloreus* lives a little longer, though it never moves from the spot, and only thrusts its snout hither and thither for a short time, and dilates its mouth. *Lineus gesserensis* does not crawl after immersion, but lies helplessly on the bottom of the vessel, a swollen body-wave passing rapidly from before backwards for some seconds, as if sickly, then all is still. In most cases, as noticed by M. de Quatrefages, a copious exudation of mucus takes place, and disintegration speedily ensues, the specimens becoming pulpy in a few hours. They are not less hardy, however, than the higher Annelids under the same circumstances.

FOOD.

The Nemerteans throughout are a carnivorous and predaceous race, either capturing living prey or devouring suitable portions of dead animals. Sir J. Dalyell observed *Lineus marinus* and his *Gordius minor viridis* feeding on fragments of mussel, the former also entering the tube of *Amphitrite* (*Sabella*) to devour the tenant, and M. de Quatrefages (after Cuvier and others), in his "Rambles,"[1] narrates that the former species is nourished by sucking the *Anomia*, a feat, however, that seems to me to be involved in obscurity. The erroneous interpretation of the proboscis of the Enopla (which he took for an alimentary organ) of course exonerates M. de Quatrefages in a manner from criticism in regard to the feeding of the animals. It may be observed, however, that the thrusting out of the proboscis noticed by him in *Polia mandilla* (*Amphiporus lactifloreus*) may have been due to other causes than hunger, and that the adherence of the same organ to a Cyclops for a quarter of an hour may be otherwise explained than on the supposition of suction. Mr. Kingsley gives a very graphic but not very accurate (since he says the proboscis assists in prehension) description of a specimen of the same species in the act of devouring a fish. *Lineus marinus*, indeed, would appear to have a very indiscriminate appetite, for not only does it devour its vertebrate and bristled superiors, but a specimen in the island of Herm swallowed an example of *Ascidia intestinalis* about an inch long and half an inch broad, which had been put into the same vessel. Mr. William Thompson, who did so much for the fauna of Ireland,

[1] Excellently translated by the accomplished Miss E. C. Otté. London, 1857.

mentions that Captain Fayrer, R.N., got an individual of the same species holding on to a bait of *Buccinum undatum* on his long line, while fishing for cod off Portpatrick. In confinement the *Lineidæ* readily feed on fragments of mussel. As soon as a specimen has come in contact with a suitable portion, the mouth is enormously dilated, the inner surface of the first part of the œsophageal region thrust outwards, and the bolus, although of considerable size, rapidly swallowed. The snout of the animal during this process is curved backwards, doubtless to afford assistance by its tactile properties, but there is no extrusion of the proboscis. They also feed on dead specimens of *Nereis pelagica, Harmothoë imbricata,* and other annelids, ejecting the bristles and indigestible portions *per anum,* and the only inconvenience which they suffer from the spines and bristles is an occasional perforation of the digestive tract and body-wall, and the formation of a vesicle in the cutaneous textures, through which the offending structures are by-and-by extruded. One specimen of *L. gesserensis* under examination boldly seized the head of a large *Nephthys,* upwards of an inch longer than itself, and partially engulphed its prey. Many, moreover, greedily swallow their fellows, and hence it is dangerous to leave examples of rare specimens together in a vessel, as the larger generally make a meal of the smaller. While thus predatory and voracious, they are in turn tolerant of much injury; for instance, a specimen of *L. gesserensis* had its head and anterior portion seized and confined in the stomach of a *Sagartia troglodytes* for about ten minutes, yet the worm afterwards got free, and crawled about as if nothing had happened. In *Cephalothrix* the contents of the digestive tract are easily observed, and in confinement often consist of fragments of each other. I have not been so successful in seeing the Enopla feed, but they probably take similar nourishment. Several of the large forms, such as *Lineus bilineatus,* have been found in the stomachs of haddocks and flounders caught off St. Andrew's Bay.

Their hardihood when confined in vessels without food has already been described.

HISTORY OF THE LITERATURE ON THE SUBJECT.

The early authors on Zoology, while conversant enough as a rule with a few of the conspicuous Annelids, altogether omitted to notice the Nemerteans. Thus no mention is made of them by Linnæus, Seba, Blumenbach, Swammerdam, and others.

In 1758 the Rev. William Borlase, F.R.S.,[1] introduced the Nemerteans to our Fauna by the following description of *Lineus marinus*:—"Fig. xiii, Plate xxvi, is the long worm found upon Careg-Killas, in Mount's Bay" (Cornwall), "which, though it might properly enough come in among the anguilli-form fishes, which are to succeed in their order, yet I chuse to place here among the less perfect kind of sea animals; it is brown, and slender as a wheaten reed; it measured five feet in length (and perhaps not at its full stretch), but so tender, slimy, and soluble, that out of the water it will not bear to be moved without breaking; it had the contractile power to such a degree that it would shrink itself to half its length, and then extend itself as before." A rough engraving of *L. marinus* accompanies this account.

Certain "marine insects" from amidst Sertularians and other Corallines are represented in Tab. iv of Baster's "Opuscula,"[2] vol. i, 1762, one of which, fig. 9, is a Nemertean, probably *Tetrastemma candida.* No further mention is made of the animal.

[1] 'The Natural History of Cornwall,' p. 255, tab. 26, f. 13. Oxford, 1758.
[2] Baster, 'Opuscula Subseciva.' Haarlem, 1762.

P. S. Pallas,[1] in the year 1766, described a Nemertean of a bluish-white colour under the name of *Lumbricus oxyurus*, which I am inclined to identify with *Amphiporus lactifloreus*, from a careful examination both of the figures and text. He mistook the proboscis for an intestine, as many subsequent authors have done, but he observed that the organ was bathed in fluid, thus recognising a very important element in the anatomy of these animals. He interpreted the stylet-region as the stomach, and detected three muscular bundles proceeding from the posterior end of the latter, so as to fix the organ to the integuments. The intestine, again, terminated in an anus at the anterior pore. The medulla or nervous trunk formed a simple white cord, he said, without ganglia. While there is much that is erroneous in the foregoing description, there is also a considerable amount of penetration and judgment evinced by the learned author, for he appears to have made out the proboscidian fluid, the dilated region of the stylets, and the muscular ribands; and it is clear that this observer would not have omitted to notice the mouth and lateral fissures if his specimen had been a typical form of the Anopla. In the same work[2] he also figures a Nemertean resembling *Lineus gesserensis*, but the only reference thereto occurs in the explanation of the Plate, viz., "Alia Lumbrici *marini* species, tota atra."

The next important contribution was from the pen of the distinguished naturalist, O. F. Müller,[3] who in the first part of his "Vermium," published in 1773, grouped the Nemerteans under the Second Division of his worms destitute of tentacles (Serpentes), and in the third head (Mutica). In his second part, published in 1774, they were included, along with *Gordius*, *Ascaris*, *Hirudo* and others, in the first subdivision (Mutica) of his Gens Helminthica. Three or four of the common species were for the first time described (some of them more than once) as *Fasciolæ*.

In the new edition of his "Natural History of Fresh and Salt Water Worms,"[4] published in 1800, the same author describes a single example of the *Lineidæ* under the name of 'Der Strömische Röd-Aat,' a species no doubt identical with *Lineus gesserensis*. He did not discriminate structure further than by supposing the lateral slits at the anterior end to be connected with the anus, and the ventral papilla (mouth) the male organ of generation. His figures are quite recognisable.

This naturalist[5] in a subsequent publication (1776) enumerates the Nemerteans under his sixth Class (Vermes), and third Order—Mollusca. It is difficult to determine with precision the species referred to in this work, unless in those cases in which further mention in the "Zoologica Danica" confirms the diagnosis. He arranged them with the Planariæ according to the number of eyes, but erroneously placed *Lineus gesserensis*, *Amphiporus pulcher*, and others, under the group of eyeless forms.

The acute and painstaking Dutch naturalist, Martin Slabber,[6] noticed a Nemertean, under the name of *Gordius marinus*, which is evidently one of the Anopla, having in his figure (where

1 P. S. Pallas, 'Miscellanea Zoologica,' pp. 146—147, pl. 11, figs. 7 and 8.

2 Op. cit., p. 216, pl. 11, fig. 9.

3 O. F. Müller, 'Vermium Terrestrium et Fluviatilium.' Havniæ et Lipsiæ, 1773-4.

4 'Naturgeschichte einiger Wurm-Arten des süssen u. salzigen Wassers.' Neue Ausgabe. Kopenhagen, 1800.

5 O. F. Müller, 'Zoologiæ Danicæ Prodromus.' Havniæ, 1776.

6 'Natuurkundige verlustigingen behelzende microscopise waarneemingen,' &c., Blad. 61, Pl. 8, f. 1. Haarlem, 1778.

the animal is seen on its edge) a conspicuous lateral fissure. It appears to be related to *Micrura fusca.*

In 1780, Otho Fabricius,[1] following O. F. Müller, placed the Nemerteans in the genus *Planaria,* under his sixth Class "Vermes." He mentions *Planaria angulata, P. rubra, P. viridis, P. fusca, P. caudata,* and *P. candida,* most of which had been previously described in the 'Zool. Danic. Prodr.' of O. F. Müller. Under the head of *Planaria fusca* (*Lineus gesserensis*) he corrects certain statements of the latter author, who had only seen spirit-preparations. He considered the aperture of the proboscis to be the mouth, and the tube itself the intestine. He also noticed that it lived in numbers under stones.

Linnæus seems to have had little or no acquaintance with Nemerteans, which were either unknown or confounded with other animals, and it was only after the labours of O. F. Müller and others had brought them into view that they were noticed in Gmelin's edition of the 'Systema Naturæ,'[2] published in 1788. They were grouped by Gmelin along with the Planarians under the Genus *Planaria,* one of the divisions of his Class Intestina. They thus became associated with intestinal worms, Lumbrici, Sipunculi, and leeches. They were classified as follows:—(1) Those without eyes; (2) those with one eye; (3) those with two eyes; (4) those with three eyes; (5) those with four eyes; (6) those with many eyes. The animals, however, were so little understood that this arrangement is not to be depended on. Nothing new was introduced in Dr. Turton's translation of this edition of the 'Systema.'[3]

Otho Fabricius, returning to the subject in 1798 described[4] three Nemerteans under the names of *Planaria angulata, P. fuscescens,* and *P. candida,* from Greenland. Like Pallas he considered the proboscis to be the alimentary organ, though he correctly interpreted the mouth in the *Lineidæ,* and the anus in both.

In the following year, 1799, Jens Rathke[5] alludes to six species of the group, viz., *Planaria badia, P. lateritia, P. sanguinea, P. carnea, P. atropurpurea,* and *P. linearis.* The first two I have not satisfactorily made out, the third probably refers to *Lineus sanguineus,* the fourth to a variety of *L. gesserensis,* the fifth may be *L. marinus,* while the sixth is *Cephalothrix linearis.* Three of the species are figured.

Lamarck, in his 'Système des Animaux sans Vertèbres'[6] mentions only one Nemertean, viz., the *Planaria rosea* of O. F. Müller.

L. A. G. Bosc[7] classified the Nemerteans with the Planarians under the true worms with elongated articulated bodies, but without external organs, placing them with the Gordii and leeches. In regard to species he follows O. F. Müller.

Montagu was the next British naturalist after Borlase who paid attention to the Nemerteans.[8] In 1804 he gave a good superficial description of the worm mentioned by the former, under the name of *Gordius marinus,* with remarks on its habits. He was, moreover, the

[1] Otho Fabricius, 'Fauna Grœnlandica.' Hafniæ et Lipsiæ, 1780.

[2] Gmelin's, 'Linnæus Syst. Nat.,' tom. i, pars. vi, p. 3087. Leipsiæ, 1788. Editio decime tertia, aucta, reformata.

[3] London, 1802.

[4] 'Skrivter af Naturhistoire Selskabet,' 4de bind, 2det hefte, p. 52 et seq. Kiobenhavn, 1798.

[5] "Jattagelser henhorende til Jndvoldeormenes og Blddyrenes Naturhistoire." 'Skrivt. af Naturhist.,' Selsk. v, 1 heft., pp. 83, 84. Kiobenhavn, 1799.

[6] Paris, 1801.

[7] 'Hist. nat. des Vers.' Paris, 1802.

[8] 'Description of several Marine Animals found on the South Coast of Devonshire.' Trans. Linn. Soc., vol. vii, pp. 72 and 73.

first to describe *Carinella annulata*. He followed previous authors in classing these and allied forms under the 'Intestina.' The same species, termed respectively the Line-worm and the Hair-worm, appeared, from Montagu's descriptions, in Dr. Turton's 'British Fauna.'[1] They were arranged in a similar manner under Class V, *Vermes,* and Order I, *Intestina,* but were placed under different genera, the former being alone, and the latter associated with *Gordius aquaticus* and *G. argillaceus.*

It is from the interesting manuscript, however, which the relatives of Col. Montagu have placed in the Library of the Linnean Society, that we gather how much and how closely the esteemed observer examined the Nemerteans. In this work he describes more than a dozen species, not a few of them for the first time, and the majority so truly, that it is with a sense of relief and satisfaction that one rises from its perusal. Little can be added to his account of the external appearance and habits of the animals; and, though he did not enter into their anatomy, he correctly interpreted the mouth and anus in the *Anopla,* and was too cautious an observer to locate the former organ in the same position in the *Enopla.* He explains that, though he termed the species above mentioned *Gordii,* this was only a provisional name until further discoveries of species should put him in a position to frame correct generic characters. To the description of the genus *Lineus* he appends the following remarks on the Nemerteans:—" Their use and general economy are little known, but we may conclude they contribute partly to the food of some fishes, and in their turn keep within bounds some smaller beings, and thus serve to support an equilibrium in the great scale of nature." A volume of carefully coloured figures, by the skilful hand of Miss E. Dorville, accompanies the manuscript.

O. F. Müller in his great work[2] described several new species, and gave figures of others mentioned in his previous works, grouping them still under the genus *Planaria.* Two of his forms, viz., *Planaria viridis* and *P. rubra* were communicated by the author of the 'Fauna Grœnlandica;' the others were *P. filaris, P. rosea, P. flaccida, P. gesserensis,* and in the fourth volume P. C. Abildgaard contributed another—*Planaria dorsalis.* The author observed the proboscis, the cephalic fissures, and the ventral slit in the *Anopla,* and likewise gave the correct position of the anus. This work then noticed seven species, most of them in a recognisable condition as regards description and figures, the latter especially deserving praise for their faithful delineation.

In 1806 J. Sowerby[3] gave the title *Lineus longissimus* to the Black Line-worm, which now bears the name of *Lineus marinus.* He first heard of it from Col. Montagu, and afterwards from Mr. Simmons, who sent specimens from Edinburgh. In his description he correctly located the mouth, and observed the longitudinal streaks on the body, as well as the tendency of the broken posterior end to decay, while the anterior remained alive. He mentions that the fishermen pull them in as they would a rope, but never find the posterior extremity, and that they estimate their length at twelve fathoms. A coloured engraving of the animal accompanies the description.

In 1811 Professor Jameson[4] included *Lineus longissimus* in his 'Fauna of the Frith of Forth,' mentioning that the worm was not uncommon on oyster-beds.

[1] 'British Fauna, containing a Compendium of the Zoology of the British Islands, arranged according to the Linnean System.' Vol. i. Swansea, 1807.

[2] O. F. Müller, 'Zoologica Danica.' Havniæ, 1788—1806.

[3] 'The British Miscellany.' London, 1806, p. 15, plate 8.

[4] 'Wernerian Memoirs.' Vol. i, p. 557. Edinburgh, 1811.

A very slight notice of the Nemerteans occurs in Pennant's 'British Zoology' (edit. 1812), two only being mentioned, and those previously described by Montagu.

Some remarks on the habits of *Lineus marinus* were made by the Rev. Hugh Davies in 1815. He observed that the animal was sensitive to light, though he could not discover eyes. He also considered that the spiral form was purposely assumed by the worm during progression, for he could not perceive how its amazing length could otherwise be transported. He thought it by no means improbable that it reached the length of twelve or even fifteen fathoms.[1] An almost verbatim report of this paper appeared next year (1816) in the 'London Medical and Physical Journal,' p. 207.

In the same year Oken,[2] in his "Lehrbuch," brings in this well-known species (*Lineus marinus*) after Nais and Lumbricus, under the name of *Borlasia angliæ*. He correctly describes the mouth, and gives a short *résumé* of what was known with regard to the Devonshire specimens, and a small outline of the species.

Lamarck, in his 'Histoire Naturelle des Animaux sans Vertèbres,' 1816, like other writers about this time, copies the arrangement of O. F. Müller. He did not think that the Planariæ were annelids, but that they approached the leeches.[3]

Cuvier, unaware of the names previously given to these animals by Sowerby and Oken, for the first time applied the term *Nemertes*[4] in 1817 to designate the species described by Borlase. He groups the animal in the second class (of his Zoophytes) "*Les Intestinaux*" (*Entozoa*, Rudolphi), and in the first order of this class, "*Les intestinaux cavitaires*," along with very heterogeneous companions, such as Lernæa and others. He thus separated them from the Planarians, which he placed under the head of the "*Intestinaux parenchymateux*." The sole species known to him was the *Nemertes Borlasii*, Cuvier, which, he says, insinuates its anterior extremity (by which he in the first instance means the tail, since he mistook the anterior for the posterior end) into Anomiæ, for the purpose of sucking the contents, a feat, it appears to me, of somewhat dubious veracity. In his second edition he left the Prostomæ amongst the Planarians, following, according to M. de Quatrefages, Dugès in this respect. In Griffith's edition[5] of the 'Règne Animal' of this author little further information is given. Of *Nemertes* it is said by way of description, "It is a worm extremely soft and elongated, smooth, slender, flattened, and terminated at one extremity by a large blunt point, pierced by a hole; widened, and broadly opened at the opposite extremity, by which it fixes itself. Its intestine traverses the whole length of the body. Another canal, probably connected with generation, winds along its parietes, and finishes at a tubercle on the margin of the wide aperture. MM. Dorbigny and de Blainville, who have seen this animal living, assure us that the wide aperture is the mouth." Besides repeating the remark about the sucking of the Anomia by *Nemertes Borlasii*, it is further explained that the animal remains sunk in the sand, and is "more than four feet long," neither of which observations adds in any way to our knowledge. The only point of interest in this description is the cautious correction of the mistake which Cuvier made in holding the anterior as the posterior end of the worm. In the illus-

[1] 'Some Observations on the Sea Long-Worm of Borlase, *Gordius marinus* of Monta.' Trans. Linn. Soc., vol. xi, p. 292.

[2] 'Lehrbuch der Naturgeschichte, Dritter Theil, Zoologie.' Erster Abtheil. &c. Jena, 1815, p. 365, tab. xi, fig. 4.

[3] 'Hist. nat. des anim. sans vert.' Paris, 1816, &c.

[4] Cuvier, 'Règne Animal.' Tome iv. Paris, 1817.

[5] Vol. xii, p. 468. London, 1834.

trated edition of the 'Règne Animal,'[1] by the disciples of the great master, M. de Quatrefages gives exactly the same description, and repeats certain of the figures—to be alluded to hereafter.

Schweigger, in his 'Handbuch der Naturgeschichte,' follows Cuvier too closely, for he now describes *Borlasia angliæ* as having a membranous disc posteriorly, and either occurring in a free state, or by aid of this disc adhering to Anomiæ.[2]

Dr. Fleming,[3] in 1822, represents the Nemerteans by *Lineus*, one of the genera of his family Gordiusidæ, the other genus being *Gordius*. He correctly observes that in *Lineus* the mouth is a longitudinal slit placed under the snout, but makes no further remark than that several species inhabit this country.

A very considerable increase to the knowledge of these animals was made by the investigations of the celebrated Italian naturalist Stefano Delle Chiaje, who, in the second volume of his 'Memorie,'[4] published in 1825, gave somewhat detailed descriptions of two Nemerteans, for which he constituted the genus *Polia*, named after the comparative anatomist Giuseppe S. Poli. In his sketch of the anatomy of *Polia siphunculus*, he mentions two muscular coats under the skin, an inner of longitudinal fibres, and an outer of transverse (circular). From the mouth springs a muscular rugose gullet (speiseröhre of the Germans), having an inner mucous coat and a fibrous layer. The alimentary canal has the same diameter, and extends throughout the entire length of the animal. In each articulation we have a right and a left sac or pouch in connection with the alimentary tube, into which the food may enter. Above the digestive tract is found a canal containing a long proboscis, which has four fibrous coats, and an internal mucous one covered with papillæ. The proboscis, moreover, is fixed to the wall of its sac by a muscular band. He imagines this to be an organ of touch, and states that when free its motions are so vermiform that one might easily mistake it for a *Lumbricus* or *Echinorhynchus*. In regard to the circulation, he observes that two arteries arise from the triangular lobe of the head, and proceed along the sides of the body, while two sacs, which have the function of hearts, occur at their commencement. In the angle of the basis are three slight whitish elevations, in connection with a whitish thread, which runs down to the middle of each artery. From the end of the mouth springs a very small vein, which gives branches to the lateral sacs (of the digestive cavity). In his other species (*Polia lineata*) he describes a prehensile disc around the anus, and the occurrence of pores on the ventral surface, analogous to the respiratory sacs of *Sipunculus*, but the position of the form is doubtful. This author therefore has the merit of being the first to anatomise these animals in a scientific manner, and to interpret fairly the physiology of the parts. He recognised the true mouth of his examples (which belonged to the Anopla), the general arrangement of the digestive tract, and the presence of distinct muscular layers in the body-wall. The errors he fell into with regard to the circulatory system may be easily explained, since he worked only with dead animals, or, at least, not with those capable of being employed as transparent living objects. The anal "sucker" in *P. lineata* may have been due to some eversion of the digestive canal, if the species pertained to this order.

[1] 'Règne Animal Illust.' Zoophytes, texte et atlas, p. 65, plates 33 and 34. Paris.

[2] 'Handbuch der Naturgeschichte der skelettlosen umgegliederten Thiere.' Von Dr. August Friedrich Schweigger. Leipzig, 1820, p. 591.

[3] 'Philosophy of Zoology,' vol. ii, p. 605.

[4] S. Delle Chiaje, 'Memorie sulla storia e notomia degli animali senza vertebre del Regno di Napoli.' Napoli, 1823—1829. 4 vols. (Vol. ii, p. 406.)

In his third volume, published in 1828, he describes several other Nemerteans. Amongst these in all probability falls also his *Planaria siphunculus.* I have not been able to identify his *Polia punctata;* the size and colour of the proboscis, and the thin edges of the body in his figure,[1] would lead me to place it near *Micrura fusca.* His *Polia oculata* is allied to *Lineus sanguineus*, but the occurrence of eight large eyes on each side, and the somewhat wide and flattened nature of the snout in his enlarged figure,[2] make it doubtful. The identification of *Polia cærulescens* is also difficult; but his *Polia geniculata* is the *Cerebratulus geniculatus* of M. de Quatrefages.

In 1829 the same author figures three species in his fourth volume, viz., *Ophyocephalus murenoides*,[3] *Tubulanus polymorphus*,[4] and *Cerebratulus bilineatus*,[5] but I cannot find reference thereto in his text farther than the simple explanation of the plate. *O. murenoides* may be a variety of *Lineus marinus*, or else a species with which I am unacquainted. *Tubulanus polymorphus* has a broad hastate head with lateral fissures. There are no stripes on the brownish ground-colour. In his description of the figure (9) of *C. bilineatus* he terms the everted proboscis "sifone genitale." In a section of the proboscis of this species, he shows at least external circular and median longitudinal fibres, although in some other respects he is obscure, since he speaks of an accessory cavity—probably from the invagination of the proboscis. A representation[6] and accompanying explanation are also given of the ovaries of *Polia siphunculus*, in which the author shows a general acquaintance with their position.

An abstract of Delle Chiaje's observations was given in 1832 in Oken's 'Isis.'[7]

F. S. Leuckart[8] in 1828 established the genus Meckelia for the reception of a species (*Meckelia somatotomus*) which he found in a runlet connected with the Mediterranean. This species was evidently a true example of the Anopla, from the description given of its cephalic fissures and mouth, and therefore it is wrong to apply the generic title to a family so diverse as that containing the *Gordius annulatus* of Montagu.

In the same year Dr. George Johnston commenced a series of papers[9] on this department of British Zoology, and he proved a most able and persevering expounder of the habits and general structure of the group, rescuing them from the almost total obscurity in which they were shrouded in this country, and giving a fresh impetus to their investigation. Errors, doubtless, he made, but they were not more striking than those of many of his contemporaries, and not a few of his successors. He described on this occasion three species, viz. *Planaria flaccida, P. unicolor*, and *P. lactiflorea.* The first refers to *Nemertes Neesii.* The second may be *Lineus sanguineus*, though he himself does not seem to have been quite sure as to what it was, since no notice is taken of it in his subsequent writings. The last is *Amphiporus lactifloreus.* The first came from deep water, the last from the littoral region.

M. Ant. Dugès established the genus *Prostoma*, also in 1828, to designate what appears to

[1] Op. cit., vol. iii, p. 172, tav. 43, f. 11. [2] Op. cit., tav. 44, fig. 1.

[3] Op. cit., vol. iv, tav. 62, figs. 6, 7, and 13—15.

[4] Op. cit., tav. 62, figs. 8 and 12.

[5] Op. cit., tav. 62, figs. 9 and 16.

[6] Op. cit., vol. iv, p. 37, and tav. 53, fig. 7.

[7] Isis, 1832, heft. 6, p. 647, taf. 10, figs. 3—5, and 11^1—11^5.

[8] 'Breves animalium quorundam maxima ex parte marinorum descriptiones, F. S. Leuckart.' Heidelbergæ, 1828.

[9] 'Zoological Journal,' vol. iii, pp. 428 and 429.

be a freshwater Nemertean (*Prostoma clepsinoïdes*), which he discovered in French streams.[1] He found that it differed entirely in type from the Planarians which he had been describing, since it did not possess their gastric ramifications, but had a simple alimentary tube (proboscis), forming several convolutions. The latter organ commenced in front by a probably exsertile mouth, and terminated posteriorly in a rounded anus.

In the same year (1828) M. de Blainville[2] placed the Nemerteans along with the Planarians under the Class *Entomozoaires apodes* ou *Vers,* in the Sub-class *Parentomozoaires* ou *Sub-Annélidaires,* and in his first Order *Aporocephala.* He established his first Family, *Teretularia,* for their classification, but associated with them *Bonellia,* a Gephyrean. His genera of true Nemerteans were *Tubulanus* (Renier), *Ophiocephalus* (Quoy and Gaimard), *Cerebratulus* (Renier), *Borlasia* (Oken), *Lobilabrum* (De Blainville), and *Prostoma* (Dugès). He correctly described the mouth in the Anopla (to which group almost all his species, with the exception of *Prostoma,* belonged), and the general characters of the animals. His figures of *Borlasia angliæ* in the Atlas are fair.

Dr. G. Johnston[3] continued his observations on Planaria in 1829, describing *Planaria octoculata, P. quadrioculata, P. bioculata,* and *P. filiformis.* The first mentioned refers to *Lineus sanguineus,* the second to *Tetrastemma candida,* the third to *L. gesserensis,* and the fourth to *Cephalothrix linearis.* His accounts are short, but easily recognised.

In 1830 M. Dugès published descriptions[4] of four species of *Prostoma,* and gave certain anatomical details. One of these, however (now called *P. clepsinoideum*), was mentioned in the previous paper; the second, *P. lumbricoideum,* is probably *Tetrastemma candida;* the third, *P. candidum,* Müller, appears to be the same species; and the fourth, *P. armatum,* has so many eye-specks that, if the description is correct, it is a species with which I am unacquainted. His anatomical investigations were made on the latter. He confounded the proboscis with the digestive system, and the nervous with the circulatory system.

Professor Huschke[5] in a notice of the anatomy of *Notospermus drepanensis* (*Cerebratulus geniculatus,* De Quatref.), from tufts of *Corallina officinalis* on the shores of Sicily, published at this time, mentions that there are two muscular coats under the skin, an external longitudinal and an inner circular; the inner longitudinal muscular coat having escaped observation. He truly interpreted the alimentary canal, with its post-ganglionic mouth and terminal anus, but mistook the proboscis for a male organ, which, however, he correctly located in a sheath between the muscles of the body-wall and the digestive tract. The lateral fissures of the head he likewise connected with the generative organs, and described and figured the nerves as semen-canals. This appears to be an example of the Anopla, and hence we are enabled to predicate as to its probable structure.

In the same year (1830) Professor Leuckart,[6] in a further note on his *Meckelia somatotomus,* calls the aperture of the proboscis the genital organ, but he correctly names the mouth. He states that the genus *Meckelia* closely resembles *Borlasia.*

In the following year (1831) our knowledge of the group received a considerable accession

[1] 'Ann. des sc. nat.,' 1re Sér., vol. 15, p. 140, pl. 5, figs. 25 and 26.
[2] 'Dict. des Sc. nat.,' vol. 57, pp. 573—577. 1828.
[3] 'Zoological Journal,' vol. iv, 1829, pp. 56 and 57.
[4] 'Ann. des sc. nat.,' 1re Sér., vol. 21, p. 73, pl. 2, fig. 1—6.
[5] 'Beschreibung und Anatomie eines neuen an Sicilien gefundenen Meerwurms.' Isis, 1830, heft. 6, pp. 681—3, taf. 7, figs. 1—6.
[6] Isis, 1830, heft. 6, p. 575.

from the labours of the illustrious Ehrenberg,[1] who formed them with others into a distinct class, which he termed Phytozoa Turbellaria. It is true he included under this head animals, such as the Gordii and Naidina, which are widely dissociated from the typical group, and, in his arrangement, placed apart genera allied in the closest manner, yet his contribution forms an epoch in the literature of the Nemerteans. He characterised the Turbellaria briefly as "Evertebrate apodous animals, creeping; often with retractile vibratile hairs; with a distinct intestinal tube; separate vessels without hearts, rarely with a mobile dorsal and abdominal vessel; hermaphrodite or with distinct sexes, oviparous and spontaneously fissile; excreting a copious mucus." The Nemerteans were placed entirely under his second order, Rhabdocœla, that is, Turbellaria with a simple cylindrical or conical intestine, having the mouth at one end and the anus at the other. The family *Micrurea* he grouped under the second section (*Monosterea*) along with the Gordii, but he more consistently classed all the other Nemerteans described by him under the third section, *Amphiporina*. His arrangement is thus, as follows:—

Section II.—Monosterea.

Fam. Micrurea.
Gen. Disorus, Micrura, and Polystemma.

Section III.—Gyratricina.

Gen. Orthostoma, Gyratrix, Tetrastemma, Prostoma, Hemicyclia, Ommatoplea, Amphiporus.
Fam. Nemertina.
Gen. Nemertes, Notogymnus.

The want of an anatomical basis for his classification rendered errors unavoidable, but his descriptions of the species are characterised by care and lucidity, and his figures are good. He erroneously considered the proboscis to be the intestinal canal, and its aperture the mouth, while the actual mouth in the Anopla he termed the genital opening. In the Enopla he could not of course find the latter. He correctly noticed the presence of an anus. Since he states that he saw a reddish viscus in *Tetrastemma flavidum* on each side in front of the proboscis (which reddish mass he took for an ovarium), it is probable he alludes to the ganglia. The stylet-region of the proboscis entirely eluded his notice.

The arrangement of this author is implicitly followed in the twelfth edition of Lamarck's 'Histoire Naturelle des Animaux sans Vertèbres.'[2]

Dr. George Johnston described and figured[3] in 1833 *Carinella annulata* under the name of *Carinella trilineata*. He was unacquainted with the previous description by Montagu in the 'Linnean Transactions.' Like many others he also called the proboscidian aperture the mouth, while the true mouth escaped his notice. He rightly stated that the anus was terminal.

Quoy and Gaimard in the same year give an account, with figures, of several Nemerteans in their zoology of the 'Voyage de la Corvette l'Astrolabe.' None of their species, however, seem to be

[1] 'Symbolæ Physicæ. Anim. everteb. exclus. insectis.' Ser. prima. Berolini, 1831.
[2] 'Hist. Nat. des Animaux sans Vert.' 12th edit., par Deshayes et H. M. Edwards, vol. iii, pp. 610—613. Paris, 1840.
[3] Loudon's 'Mag. Nat. Hist.,' vol. vi, p. 232.

identical with the British forms. They correctly interpreted the mouth in the Anopla, but erroneously considered the aperture of the proboscis a genital pore, representing, moreover, as a parasite (Plate M, fig. 14) the proboscis escaping from the mouth of a specimen of *Borlasia tricuspidata.* A *Tetrastemma,* with a deeply notched snout and four large eyes ("Borlasie à quatre points"), which they took in the sea near Amboyna, was found inhabiting an *Anatifa,* but whether it occurred there accidentally or otherwise we are not informed. The worms are placed under the Zoophytes in the group "Vers Apodes."[1]

In 1838 Dr. George Johnston published further interesting observations on the genus *Nemertes,*[2] mentioning nine species as occurring on British shores. His general anatomy remains as before, the proboscis being described as the alimentary organ; but he rightly observed that one section of the worms had and another had not stylets in the proboscis; and accordingly this formed the basis of his classification. He termed the true alimentary chamber the general cavity of the body, though he qualified this description by saying that the lateral cæca were parts of the digestive system. He also observed that the ova were independent of these cæca, and were developed between them and the skin. He, however, thought the mouth in *Lineus sanguineus* a nerve-ganglion, and in the entire group called the ganglia "hearts." He discovered the gregariniform parasites infesting *Lineus,* though he could not make out their nature. Two plates of very fair figures accompany this paper, from the pencil of his accomplished lady. If M. de Quatrefages found that his species—*Polia purpurea,* 'Voy. en Sicilie,' ii, p. 122—approached very closely the *Nemertes* or *Borlasia purpurea* of this author, it must have belonged to the Anopla, and have had lateral fissures.

W. S. Macleay, in his remarks on the Annelida in Sir R. Murchison's 'Silurian System' (1839), considered the Nemerteans as aberrant annelids, classifying them along with the Lumbrici and leeches, under the group *Apoda,* in which the body was without a distinct head or feet. The "Nemertina" were further characterised as aquatic, without eyes or antennæ, and with indistinct articulations, which, indeed, were only visible in contraction. Special reference is made to the long vermiform impression in the Cambrian Rocks of Llampeter, which is termed *Nemertites Ollivantii,* Murchison; but, so far as I can judge from the description and plate, this is a very doubtful Nemertean.[3]

In 1840 Professor E. Grube[4] made some observations on the Nemerteans of the Adriatic, describing several species, two of which are figured, viz. *Polia delineàta,* Delle Chiaje, and *Meckelia annulata,* Grube. The latter, however, is the *Notospermus drepanensis* of Huschke; and, while I am not acquainted with the *Borlasia annulata* of Ehrenberg, another which he mentions, his *Borlasia viridis* appears to be allied to *Lineus gesserensis.* Under Ehrenberg's name *Amphiporus,* he also refers to what, in all probability, is an example of the Enopla; but the identity of this form, or the succeeding new eyeless type *Akrostomum Stannii,* Grube, cannot be determined. This veteran investigator of the annelids and their allies recognised the correct situation of the apertures of the proboscis, mouth, and anus. He observed that the

[1] 'Voyage de découverts de L'Astrolabe—sous le commandement de M. J. Dumont D'Urville.' Zoologie, par MM. Quoy et Gaimard, tome quatrième. Paris, 1833.

[2] "Miscellanea Zoologica," 'Mag. Zool. and Bot.,' vol. i, pp. 529—538, pls. xvii and xviii.

[3] Murchison's 'Silurian System,' vol. ii, p. 699, pl. xxvii, f. 4.

[4] 'Actinien, Echinodermen und Würmer des Adriatischen und Mittelmeers,' pp. 57—60, figs. 7, 7*a,* 8, and 8*a.* Königsberg, 1840.

former had a special sheath, and that it was not connected with the alimentary system, which lay beneath it.

During the same year (1841) the valuable 'Descrizione e Notomia Animali Invertebrali,' of Delle Chiaje, was published at Naples, containing further and important observations on the Nemerteans. It has, indeed, been aptly said by the lamented Professor Claparède, that the productions of this author form zoological mines, from which succeeding investigators may quarry out much that is new and rare. In this fine work the author describes the Nemerteans as *Annelosi Polici*, and considers they offer certain analogies with the leeches, on account of the structure of the alimentary canal, while in the form of their bodies they approach the Planariæ. A good description is given of the digestive tract and its "hepatic sacs," with their varying arrangement, *e.g.* "pinnatifid-bifurcate" in *Polia delineata*, and bifid in *Polia rosina;* but he falls into the error of regarding the stylet-region of the proboscis in the Enopla as the stomach, and exhibits an imperfect and inverted figure of the region (Tab. 104, fig. 22; vol. v, p. 42) in the *Prostoma candidum* of Dugès. He, however, correctly interpreted the relations of the proboscis to its sheath, the anatomy of the generative organs, and showed an elaborate series of branching transverse arteries between the dorsal and lateral vessels in *Polia sifoncello*. Many species are described and figured, and for the first time he notices the semi-parasitic habits of *Polia tetrophthalmata*, which he found in the respiratory cavity of "*Ascidia mammellata*." Besides the new species, the descriptions and remarks concerning the old enable us to determine more clearly their nature and relationships.[1]

Mr. W. Thompson[2] contributed at this time, under the head of "Additions to the Fauna of Ireland," an account of some species of Nemerteans, viz. *Nemertes gracilis*, *N. lactiflorea*, *Carinella trilineata*, and *Gordius annulatus*. The two latter refer to the same species, viz. *Carinella annulata*, the one being Dr. Johnston's name, the other Montagu's prior title.

In P. Gaimard's 'Voyages en Scandinavie, en Laponie,'[3] &c., considerable attention is devoted to the Nemerteans; but, as only the plates of this work could be procured in the British Museum, its examination is incomplete. However, as none but he who is conversant with the anatomy of the parts can correctly represent in a drawing so minute and complex structure as is found in the proboscis of the Enopla, we may with propriety make a few remarks on these plates. In Plate C, most of the figures, from 1 to 20, seem to pertain to *Amphiporus pulcher*, and therefore the slit which is shown behind the ganglia in fig. 9 is erroneous. The entire animal is well represented in fig. 20. Figs. 23, 24, and 28 belong to a species resembling *Nemertes gracilis*. Fig. 1 of Plate D would do for *Amphiporus lactifloreus*. The whole of Plate E is devoted to the Nemerteans, and in this the structure of the proboscis of the Enopla is detailed. In Plate F a curious form is delineated (figs. 1 and 3), with a spear-shaped snout, a flattened body and widened tail. It appears to be an intermediate type between the Nemerteans and Planarians, and probably is a swimmer. The drawings were made by G. Boeck.

Œrsted,[4] in the fourth volume of 'Kroyer's Naturhistorisk Tidsskrift' for 1842-43, wrote

[1] 'Descrizione e notomia animali invertebrali della Sicilia citeriore osservati vivi negli anni 1822—1830,' da S. Delle Chiaje. Napoli, 1841.

[2] 'Ann. Nat. Hist.,' vol. vii, 1841. p. 482.

[3] 'Voyages de la Commission Scientifique du Nord en Scandinavie, en Laponie, au Spitzberg et aux Feröe, sur la corvette La Recherche.' Paris, 1842, &c.

[4] Kroyer's 'Naturhistorisk Tidsskrift,' Fierde Bind. Kiobenhavn, 1842—1843.

a paper on Planaria and Nemertes, promulgating those views, which afterwards were given at length in his 'Entwurf,' and which therefore need not be further alluded to here. The Nemerteans especially are curtly dealt with.

H. Rathke, in a very excellent structural chapter in 1843,[1] amended the errors of Dr. Johnston in regard to the mouth in *Lineus*, and described correctly the digestive system, the position and relations of the proboscis and other points. He was inclined to think the proboscis an organ of touch.

In the same year (1843) we have the forerunner of a series of elaborate investigations by M. de Quatrefages,[2] who notified to the Academy that he had found separate sexes in the Nemerteans, with the development respectively of ova and spermatozoa, as in the Annelids. He promised to make known the complete results at a future period.

M. Milne Edwards,[3] in reporting on the papers of M. de Quatrefages, in 1844, states, with regard to the Nemerteans, that the latter found that they approached the Annelids in the general distribution of their vascular system, the leeches in the structure of their buccal apparatus, and other points in their organisation; yet their reproductive organs were analogous to those of many helminths. Their nervous system he compared to that of the "Lingules," and he likened their digestive system (with a cæcal termination) to that of the lower helminths and zoophytes. The majority of these homologies are placed on no reliable data.

In 1844 A. S. Œrsted contributed a valuable addition to our knowledge of the Nemerteans and allied genera.[4] He classed the Nemerteans as the fourth sub-order (*Cestoidina*) of his order Apoda, the others in their respective positions being (3) *Trematodina* (Hirudinea and Planariea), (2) *Acanthocephalina* (Siphunculacea), and (1) *Nematoidina* (Gordiea). The sub-order *Cestoidina* was thus characterised:—"Body linear, rounded rather than flattened, much longer than broad, indistinctly marked by soft annulations, covered with vibratile cilia; distinct muscles, but no true nerves (?). Eyes 2, 4, 6, 8, 10, many or none. Respiratory organs absent or in the form of lateral fissures on the head, which conduct the water to the proximity of the hearts. Complete circulation with two hearts. Digestive tube simple, with the aperture of the mouth situated ventrally (rarely terminal), and a terminal anus. Sexes separate; in each a stimulating copulating organ. Testicles and ovaries similar in structure except as regards contents (ova or spermatozoa), numerous, and placed laterally in each segment." The author thus confounded the ganglia with hearts, and hence was led to believe that the cephalic fissures were connected with respiration, in so far as they permitted a closer relation between the sea-water and the contents of the supposed hearts. He had a fair notion of the digestive system, but he misinterpreted the physiology of the proboscis. He arranged the sub-order into two families and eight genera, thus:—

[1] 'Beiträge zur Fauna Norwegens,' &c., pp. 231—237.

[2] 'Comptes Rendus,' tom. xvii, Dec., 1843, p. 424.

[3] 'Ann. des sc. nat.,' 3ème sér., tom. i, pp. 20-21.

[4] 'Entwurf einer systematischen und speciellen Beschreibung der Plattwürmer,' &c. Copenhagen, 1844.

I. *Fam.* Nemertina.

Mouth inferior; anus terminal.

(1) Body filiform, equally attenuated at either extremity (head indistinct); no respiratory fissures.

a. Mouth and ovaria or testicles considerably removed from the snout. Genus 1. *Cephalothrix.*

b. Mouth and ovaria or testicles not much removed from the snout. Genus 2. *Astemma.*

(2) Body linear, rounded, more or less dilated anteriorly (head distinct), respiratory fissures distinct or none.

a. Head distinguished from the body, no respiratory fissures. Genus 3. *Borlasia.*

b. Head not distinguished by a constriction from the rest of the body, respiratory fissures more or less distinct.

α. Eyes in groups. Genus 4. *Polystemma.*

β. Eyes 8—16, biserial. Genus 5. *Nemertes.*

γ. Eyes 4. Genus 6. *Tetrastemma.*

(3) Body linear-oblong, flattened, equally obtuse at either extremity, respiratory fissures distinct. Genus 7. *Cerebratulus.*

II. *Fam.* Amphiporina.

Aperture of the alimentary tube terminal. Genus 8. *Amphiporus.*

The foregoing classification, being founded on external appearances, could not be expected to stand, the more so as the writer's knowledge of the anatomy of the groups was imperfect.

In this author's 'Inaugural Dissertation'[1] (for M.A.), published about the same time, mention is made of the Nemerteans and other marine animals occurring in the Sound—in the various zones, viz. those of the Trochi, Gymnobranchs and Buccini (corresponding with the Littoral, Laminarian and Coralline of Forbes). Little or no additional information on the subject is obtained in this work, mainly on account of the difficulty in recognising his species. He does not note the presence of any in the Laminarian zone.

Mr. H. Goodsir, in 1845, made some remarks on certain of the Anopla, viz. *Serpentaria fragilis* and "*Nemertes gracilis,*" but his observations are characterised by serious structural defects, apparently from too limited observations.[2] He termed the nerve-ganglia and cords the testicles, and this upon the faith of his microscopic researches. He considered the alimentary canal, again, a space common to the respiratory, digestive, and generative systems; his digestive tract being the proboscis. He thought that in *Serpentaria* each of the "annuli," or fragments, contained all the elements of the perfect or original animal, viz. a male and female generative apparatus, the

[1] 'De regionibus marinis.' Havniæ, 1844.

[2] "Descriptions of some Gigantic Forms of Invertebrate Animals from the Coast of Scotland," 'Ann. Nat. Hist.,' vol. xv, p. 337, pl. 20, f. 1—3. 1845.

cavity common to the generative, digestive, and respiratory functions, and a small dorsal vessel analogous to the intestinal canal of Nemertes.

A very interesting brochure on the Nemerteans[1] was contributed by Prof. Kölliker in 1845, a paper, I may remark, which has received too little attention from some continental writers. After indicating the ordinary characters of the group, the author gives a general account of their anatomy, correctly describing the mouth, alimentary canal and anus, the situations of the ganglia and the branches of the lateral nerves. He also notes the occurrence of lenses in the eyes of certain species. He is in error, however, when he states that he found two hearts with coloured blood in the head of *Nemertes roseus;* and that the proboscis is attached to the wall of the body posteriorly. He observed the stylet-apparatus in several species. His classification of the Nemerteans was founded, somewhat curiously, upon the presence or absence of a sheath to the proboscis, thus :—(1) With the proboscis floating freely in the body-cavity; body ciliated, and smoothly rounded. (2) With a smooth body, and the proboscis confined in a sheath. The latter group he again subdivided into (*a*) those with a flattened head and lateral furrows, and (*b*) those having neither a flattened head nor lateral furrows. He describes ten species, most of which are stated to be new. One of these is the strange *Nemertes carcinophila,* which he found in an apparently parasitic condition amongst the ova of the common shore-crab.

Dr. Johnston, in his 'Index to the British Annelides'[2] (1846), described a few additional Nemerteans; but this paper does not require further mention at present, except to observe that he arranged his species under five genera, viz., *Borlasia, Lineus, Serpentaria, Meckelia,* and *Prostoma,* which were comprehended by the Sub-family *Lininæ* of the Family *Planariadæ,* Tribe *Nemertinea* and Order *Apoda.*

In the same year (1846) M. de Quatrefages published his observations on the Nemerteans,[3] but as a more complete edition of his acute and comprehensive labours (especially as regards figures) subsequently appeared, I shall in the meantime reserve further criticism. A notice of this paper, with an appendix of his classification, was given in Froriep's 'Neue Notizen.'[4] Before the appearance of the foregoing, he had also made some remarks on the proboscidian fluid and circulation of the Nemerteans in his "Note sur le sang des Annélides" in the previous volume (V) of the 'Annales.'

This author observes[5] that he had found in the rocks of Solenhofen certain imprints which he considered difficult to attribute to other than Nemerteans. The impressions indicate cylindrical coiled animals, resembling these worms after immersion in alcohol. In the chips of stone from Strasbourg he thought the forms referable to the Genus *Borlasia,* and especially resembling *Lineus marinus.*

In 1847 the celebrated J. Müller[6] described and figured *Pylidium gyrans,* as a larva from Heligoland; but he did not then find out its connection with the Nemerteans, and indeed was in doubt as to its actual relations.

[1] 'Verhandlungen der Schweizerischen Naturforschenden gesellschaft bei ihrer Versammlung zu Chur, 1844,' pp. 89—93. Chur, 1845.

[2] 'Ann. Nat. Hist.,' vol. xvi (Supplement), pp. 433—462, pl. xv.

[3] "Études sur les types inférieurs de l'embranchement des annéles. Mémoire sur la Famille des Némertiens" (Nemertea). 'Ann. des sc. nat.,' 3ème sér., Zool., tom. vi, pp. 173—303, pls. viii—xiv.

[4] Froriep's 'Neue Notizen,' bd. xxxix, 1846, p. 276. From the 'Institut,' No. 660, 26 Aug., 1846.

[5] "Soc. Philom. Extr. Procès verb. 1846." 'L'Institut,' xiv, 1846, No. 664, p. 154.

[6] 'Archiv für Anat.,' 1847, p. 159, taf. vii, f. 1—4.

Dr. Joseph Leidy [1] in the same year (1847) published notes on what appears to be a small freshwater Nemertean (*Prostoma marginatum*), but his remarks are so indefinite that they are of comparatively little value.

Frey and Leuckart next made some excellent observations, in their 'Beiträge' (1847), on the structure of the Nemerteans.[2] They described the ciliated coating, and pointed out that in these animals the spike-cells (Nesselorgane) present in the Planariæ were wanting. They mentioned two muscular coats—an outer longitudinal and an inner circular coat, and that the nerve-trunks lay on the inner side of the latter. The differences in regard to the ganglia of Tetrastemma and Borlasia were shown, the authors demonstrating the shape of the organs in the former by a drawing from *Tetrastemma variabilis,* of which, however, no additional mention is made. The cephalic sacs in Borlasia (*Lineus*) were thought to be appendages of the ganglia. They did not enter into the structure of the proboscis further than to mention that it has longitudinal and circular muscular fibres; but they correctly observed that its muscular ribbons were attached to the wall of its sheath, within which sheath a fluid with corpuscles existed. They did not know whether the generative products escaped through the body-wall, or by rupture at the posterior end, as in *Arenicola;* and at any rate rupture of the body-wall might ensue for this purpose, for it was not very likely that these products escaped into the body-cavity. Lastly, they compared the Nemerteans with the Flukes and Trematoda. On the whole they correctly appreciated most of the structures detailed by them.

The only book of Renier's which I have been able to examine is the posthumous volume on the zoology of the Adriatic, edited by Professor G. Meneghini (1847).[3] In this work the mouth of the Anopla is thought to be the genital opening, and the aperture for the proboscis the mouth. Little attention is paid to the proboscis, and the anatomy of the group in general is much less precise than that of Delle Chiaje. The drawings, also, which accompany the text, are indifferent. Six species are described, only one of which, however, appears to be British, viz., *Siphonenteron elegans* (Renier), which Meneghini avers is identical with the *Valencinia ornata* of De Quatrefages, and therefore with the common *Carinella annulata* of Montagu.

E. Blanchard in 1847 gives a brief but important notice of the structural position of the *Nermertina,* Ehrenberg.[4] After having shown the principal differences between the Anévormes (*Bdellomorpha, Dendrocœla,* and *Trematoda*), the Cestoidea and the Helminths, he contrasts the whole with the Nemerteans. (1) In regard to the *Nervous system.* He considers the cephalic ganglia of the Nemerteans analogous to the sub-intestinal ganglia of the other annelids; and states that their disposition quite differs from that of the Anévormes in general, and the Planarians in particular. They have no closer analogy with the Nematoidea in this respect. (2) The *Circulatory system,* he observes, presents nothing in common. (3) *Digestive system.* He follows M. de Quatrefages in describing the digestive canal (proboscis) as simple in the Nemerteans, whereas in the Planarians it is branched. (4) *Generative system.* He agrees with the former author also in regard to his designating the Planariæ and Trematoda *Turbellaria monoïques,*

[1] 'Proceed. Acad. Nat. Sc. Philadelph.,' vol. iii, 1847, pp. 251-2.

[2] "Zur Kenntniss vom Bau der Nemertinen," 'Beiträge zur Kenntniss Wirb. Thiere,' &c., pp. 71—8 and 150, taf. i, f. 14—16. Braunschweig, 1847.

[3] 'Osservazione postume di Zoologica Adriatica del Professore Stefano Andrea Renier,' edited by Prof. G. Meneghini. Venezia, 1847.

[4] 'Ann. des sc. nat.,' 3ème sér., Zool., tom. viii, pp. 123—127, pl. ix, f. 5.

while the Nemerteans are *Turbellaria dioïques.* As regards the separation of the sexes, the Nemerteans approach the Nematoda, but the configuration of their organs is entirely dissimilar. He hints at other differences in connection with the teguments and form of the body, but adds that in a rigorous examination these are of secondary importance. He concludes with the following remarks :—"Thus having shown how the Nemerteans differ from the Planarians in their entire organization, having exhibited these differences to be profound and characteristic, having demonstrated how far they diverge from the Nematoda in essential structure, we arrive at the necessary conclusion that the Nemerteans constitute a group quite unlike those with which we have been contrasting them, and that their affinities do not link them more closely to the Nematoda and Anévormes in general than to the Planarians in particular." The author thus rather exaggerated the gulf between the latter and the Nemerteans, being misled by the erroneous observations of M. de Quatrefages on the digestive system.

In the same paper M. Blanchard goes on to describe *Cerebratulus liguricus,* one of the Anopla, chiefly with respect to its circulation. He mentions that on account of the delicacy of Nemertean tissues he had to add a small proportion of a salt of mercury to the sea-water, so as to enable him to inject the vessels. He states that the dorsal vessel shows no ramifications, but passes forwards to the cephalic region to unite with the two lateral vessels by the communications around the proboscis and nerve-centres, the latter being bathed by the circulating fluid. He contrasts this arrangement with the observations of M. de Quatrefages, but he was not aware that essential differences exist in this respect between the Anopla and Enopla. He saw transverse ramifications between the lateral vessels, and appears to have noticed the network in the œsophageal region, though he speaks of an internal lateral vessel, of whose presence we are unacquainted. He thought that transverse ramifications of the longitudinal vessels existed in all the Nemerteans, for he also observed them in *Polia geniculata,* Delle Chiaje, and in a *Valencinia* of undetermined species; and agreed with M. de Quatrefages as to the presence of proper walls to the vessels. The Nemerteans, therefore, have a vascular network comparable with that in the Anévormes, presenting nevertheless differences in anatomical disposition. The circulatory apparatus in these worms is perhaps more complete than that of the Aporocéphales (Planarians) or the Trematoda; for the dorsal vessel seems to carry the blood forwards, and the lateral backwards, though the oscillations are irregular. He would place the Nemerteans, consequently, in a division adjoining the Anévormes, both on this account and the higher development of their nervous system.

Von Siebold,[1] in 1848, took the bold step of severing the Nemerteans from the Planarians by the intervention of the Rotatoria; and though we would not approve of such disjunction, the soundness of his decision in separating them from the Helminths can scarcely be questioned. He arranged them as the first Order of the Ringed worms :—

Order I. *Apodes.*—Body without bristles. Sub-order 1. *Nemertini.*—Body posteriorly without an anus (Ausangeorgane); head often with lateral respiratory fissures.

His information is derived from Rathke and other observers.

This author subsequently gave abstracts of various papers on the Nemerteans in the 'Archiv für Naturgeschichte.'[2]

[1] 'Lehrbuch der Vergleichenden Anatomie,' von V. Siebold u. Stannius. Berlin, 1848.

[2] 'Archiv für Naturgeschichte,' 1850, p. 382, &c.

In a subsequent paper in the 'Annales' for 1849,[1] M. Blanchard adopts the general anatomy of the Nemerteans given by M. de Quatrefages, and agrees with the latter in thinking that the affinities of the group lie rather with the Helminths than the Planarians, on account of the erroneous view with regard to the cæcal nature of the digestive tract. Moreover, in all the known Aporocéphales (Planarians) the sexes are united in one individual, whereas in the Nemerteans they are separate. The latter likewise have a veritable œsophageal collar, which is wanting in the former. He proposes the name *Aplocœla* as distinctive of the characters of the group (the simplicity of their intestine), and thinks that the title Nemerteans should be applied only to a tribe or family. No fresh observations are produced in this paper, and the errors in regard to the digestive system are rendered more conspicuous.

M. de Quatrefages at this time published his valuable and extensive observations, begun at the *Iles Chausey* in 1841, and carried on subsequently at St. Malo, St. Vaast-la-Hougue, Brehat, Sicily, &c., on the anatomy and zoology of the order, with additional coloured plates, in the second volume of the 'Voyage en Sicilie,' the joint work of Milne Edwards, Blanchard, and himself.[2] The author, after giving an account of the history of the group, proceeds to treat of their characteristics and classification thus:—

Nemertians.—Nervous system distinct, composed of two lateral lobes united above by a slender commissure, beneath by a broad sub-œsophageal commissure, and giving origin to two isolated longitudinal nervous trunks. Circulatory system shut; circulation complete. Alimentary tube simple; proboscis exsertile; intestine cæcal. Sexes separate; reproductive organs placed at the sides of the abdominal cavity, and occurring throughout the entire length of the body. Surface quite smooth, covered with vibratile cilia. He distinguishes his six genera as follows:

NEMERTIANS	Nerve-trunks entirely lateral in position	Mouth subterminal, inferior			*Valencinia.*
		Mouth terminal	Body very long	Very flat	*Borlasia.*
				More or less rounded	*Nemertes.*
			Body short	Very proteiform	*Polia.*
				Form less variable	*Cerebratulus.*
	Nerve-trunks sublateral				*Œrstedia.*

This arrangement, from the inaccuracy and limited extent of his observations in regard to the position of the nerve-trunks in the various groups, is useless; and the subordination into genera rests upon an equally unreliable basis. Not a few in his list of thirty-two species are forms previously known, though described as new worms—several more than once; and it is to be remarked that some of the very common specimens, *e.g.* *Lineus gesserensis* and *L. sanguineus*, are not mentioned, or else are so described as to be unrecognisable.

He characterises the animals as chiefly nocturnal in their habits, with the exception of *Polia*

[1] "Recherches sur l'organisation des Vers," 'Ann. des sc. nat.,' 3me sér., Zool., tom. xii, pp. 28—35.

[2] 'Recherches Anatomiques et Zoologiques faites pendant un Voyage sur les côtes de la Sicilie et sur les divers points du littoral de la France,' par MM. H. Milne Edwards, A. de Quatrefages, et Emile Blanchard; deuxième partie, pp. 85—220; pls. ix—xxiv, par A. de Quatrefages. Paris, 1849.

mandilla (*Amphiporus lactifloreus*), and notices the ease with which the latter species can be kept in confinement. He remarks that his captive specimens thrust out their proboscides and stylets, probably for the purpose of capturing the Infusoria that swarmed in his vessels. Moreover, he also saw a little *Polia* attack a Cyclops. I am, however, of opinion that all the interesting motions he witnessed in such cases were accidental, and not due to predaceous habits. There is no wonder he found no débris of food in the proboscis, since this is not at all an alimentary organ. He observed their tolerance of pressure between glasses under the microscope, and the fatal result of immersion in fresh water, but gave no remarks of importance in regard to the reproduction of lost parts.

In the second division of the memoir he discourses on the anatomy of the Nemerteans, and it may suffice at present only to allude to his results. He was certainly one of the first to anatomise the animals in a truly scientific manner, and his drawings of structure, though scarcely accurate, are very beautiful. He is wrong in averring that a fibrous layer exists in connection with the dermal tissues; his muscular coats of the body-wall (external longitudinal and internal circular) agree neither with the arrangement in the Enopla nor with that in the Anopla; the description of the general cavity of the body is obscure and misleading, and he located the corpuscular fluid there instead of in the proboscidian sheath; he altogether went astray in his interpretation of the proboscis, which he took for a digestive system (dividing it into proboscis, œsophagus, and intestine), and even his anatomy of the organ (proboscis), as it exists, is erroneous. He only examined the circulation in the Enopla. He confounded the generative with the true digestive system, and, indeed, fell behind the early observations of Dugès in this respect.

In the third part he treats of the analogies and zoological affinities of the Nemerteans, which he regarded as the degraded representatives of a more elevated type. While descanting on their general structure and relations, he observes that the organic apparatus presents the same complication in the large *Lineus* as in the minute *Tetrastemma*, but the elements (of such structure) undergo a degradation in the latter; a statement which is somewhat obscure, since the types of the forms differ entirely. For the same reason his comparison of the integuments of *Borlasia angliæ*, *Nemertes balmea*, and *Polia filum*, is fallacious. He points out that no part of the vascular system is in immediate contact with the respiratory surface, while the vessels are always plunged in the liquid of the abdominal cavity, which he therefore considers as the active agent in nutrition. He compares this corpuscular fluid to the *chyle*, for, he says, into it the products of digestion are transmitted directly from the alimentary tube (proboscis); further, it resembles the *lymph*, because it receives the internal products of the organism; finally, it is like the *blood*, because it is the direct agent in the nutrition of the eggs, and, since it bathes the muscular coats of the body, it is also charged with their nourishment. With so formidable an array of functions for this (proboscidian) fluid, it is no wonder he asks—whether the contents of the blood-vessels merit the name of blood? He was not aware, however, that this fluid is enclosed within a special muscular sheath, and nowhere comes in contact either with blood-vessel, body-wall, or ovaries.

With regard to systematic arrangement, M. de Quatrefages retains the class *Turbellaria* of Prof. Ehrenberg, exclusive of *Gordius* and *Nais*, and which he would apparently link on to the *Trematoda* of M. Milne Edwards. He does not altogether place the Planariæ and Distomæ together, but mentions that if further researches should reveal the same vascular apparatus in the former as M. Blanchard has found in the latter, then there is no obstacle to their sequence. He regarded the *Rhabdocœla* as intermediate between the Planarians and Nemerteans; resembling the former by the general disposition of their genital organs, the union of the sexes, and the organs of the senses; the latter by the simplicity of the digestive canal and the disposition of the vascular and nervous systems. He places the Nemerteans under the second sub-class of the Turbellaria, for which he advances the term *Miocœla*,[1] thus:

Class.	Sub-classes.		Orders.
TURBELLARIA	Turbellaria "Monoïques"	Intestine ramified . . .	*Dendrocœla.*
		Intestine simple . . .	*Rhabdocœla.*
	Turbellaria "Dioïques"	. . . .	*Miocœla.*

Various authors have followed more or less closely the descriptions and classification of De Quatrefages. Milne Edwards, for instance, in 1859 gives a summary of the views then known with regard to the Nemerteans, but inclines to the side of his distinguished countryman. Hence he observed that he considered it premature to decide as to the presence or absence of an anus, and to declare the fundamental structure of the digestive apparatus. This publication of M. de Quatrefages constitutes an important era in Nemertean literature, and, notwithstanding its errors, shows that the talented author strove to extend our knowledge of the structure of obscure invertebrate animals, at a time when such work was less common, and the instruments for minute research less complete.

In 1849 R. Leuckart[2] describes a Nemertean under the name of *Amphiporus Neesii*, Œrst., which in all probability refers to the common British form. He correctly locates the position of the mouth in the Anopla, but he does not define its position in the former (one of the Enopla) further than by mentioning that it is on the ventral surface, and in the form of a small fissure without swollen lips. The other species, viz. *Nemertes fusca*, *N. annellata*, and *Polia canescens*, described in this paper, I have not been able to determine.

The publication of the 'Systema Helminthum' of C. M. Diesing in 1850 is chiefly interesting in regard to his classification of the group.[3] He arranged the Nemerteans as the third tribe of his second order (*Turbellaria*) of his first sub-class and section *Achaethelmintha*. He characterised them as worms having a very contractile body, for the most part flattened or rounded, much longer than broad. No anus. Sexes distinct. This tribe (Nemertinea) he divided into four sub-tribes, according to the presence or absence of lobes or fissures, viz., *Holocephala*, *Lobocephala*, *Ptichocephala*, and *Rhagadocephala*, distinguishing the genera according to the presence or absence of eyes, position of the mouth, so-called genital aperture, and other evident external characters. The complete confusion apparent in the incongruous grouping of the genera by the author makes it advisable to dwell no longer on this phase of Nemertean history. His classification is quite worthless, and could only have been constructed by one almost totally unacquainted with the animals otherwise than from descriptions, which, unfortunately, were too often misleading.

[1] From *μειόω*, to diminish, and *κοιλία*, intestine.

[2] "Zur Kenntniss der Fauna von Island," 'Archiv für Naturges.,' 1849, p. 149.

[3] 'Systema Helminthum,' vol. i, pp. 182 and 183, and pp. 238—277. Vindobonæ, 1850.

A valuable paper on the embryology of Nemertes was produced by E. Desor in 1850,[1] which for the first time disclosed the remarkable development in certain of the Anopla. His observations were made on a species, from the shores of New England, allied in the closest manner to the common British *Lineus gesserensis*. The ova are laid in the form of flask-shaped capsules, each of which contains from one to seven yolks. Desor discovered that after a time the yolk becomes ciliated, and that the young *Lineus* emerges from this ciliated investment, so that just before extrusion there are two spheres of ciliation, viz. the external coating, and the skin of the contained embryo.

Dr. Joseph Leidy[2] described in 1850-51 a species of Rhynchoscolex (*R. simplex*), which is probably a Nemertean, and a new genus, *Emea*, constructed for the reception of a freshwater species from the neighbourhood of Philadelphia. He calls the proboscis the alimentary tract, and the stylet-region a gizzard armed with a dental apparatus. In the former, he states, are numerous villose appendages (evidently referring to the glandular papillæ of the proboscis). He recognised the proboscidian fluid and its corpuscles, but he defined it only as occupying the interior of the body. His statement that the generative system consists of two tortuous and capacious tubes is also open to doubt.

In a second paper in the same volume[3] he mentions *Meckelia lactea*, n. s., a form which can swim like an eel. This is evidently one of the Anopla, yet he terms the mouth the generative aperture.

In a third communication[4] he makes some amendments in the description of his genus *Emea*, apparently after having seen the memoirs of De Quatrefages. He now observes that the *œsophagus* is styliferous, being "furnished at its bottom with a single spine or nail-like tooth, and four others on each side in a rudimentary condition, enclosed in a sac." He likewise says that the *intestine* becomes obliterated posteriorly, whereas he formerly stated that the mouth and anus were terminal.

In a paper remarkable only for the unsoundness of the views contained therein, Mr. Charles Girard, in 1851, proposed to class the Nemerteans and Planarians with the Mollusca, and not with the Annelids at all.[5] It is scarcely necessary to enter into his theories, but it may be interesting to note that this reformer rests his conclusions on so many grounds (with special reference to the Nemerteans) as the following:—Their soft, glutinous, ciliated body; their simple nervous system, consisting of a small number of cephalic ganglia; their eye-specks, development and habits.

Dr. Max S. Schultze published an important work during the same year on the *Turbellaria* of Ehrenberg, accompanied by exquisitely engraved copper plates.[6] The Nemerteans, however, were but briefly alluded to in the third part of the treatise, under the heads of *Prorhynchus stagnalis* and *Tetrastemma obscurum* respectively. The former is chiefly interesting on account of the atrophied condition of the proboscis and its stylet-apparatus, which the author considered to be an aggressive organ, poison being instilled into wounds by the contraction of the posterior chamber. It forms an advantageous comparison with the aberrant *Nemertes carcinophila*.

[1] 'Boston Journ. Nat. Hist.,' vol. vi, No. 1, pp. 1—12, pls. 1 and 2.

[2] 'Proceed. Acad. Nat. Sc. Philadelph.,' vol. v, p. 125.

[3] Ibid., pp. 223 and 224.

[4] Ibid., pp. 287 and 288.

[5] 'American Journ. Sc.,' 2nd ser., vol. xi, No. 31, pp. 41—53.

[6] 'Beiträge zur Naturgeschichte der Turbellarien.' Erste Abtheilung. 7 pls. Greifswald, 1851.

Many valuable remarks occur in the article on *Tetrastemma obscurum* concerning the proboscis, the development of the stylets, the position of the mouth, the digestive and circulatory systems. He over-estimated the relation of the marginal stylets to the central, for he thought that the former supplied new organs to the latter. He also confounded the circulatory with a water-vascular system. He, however, exhibits great care and accuracy in his observations, which put Nemertean anatomy on a sounder footing than it had hitherto held.

He divided the Turbellaria into two sub-classes, thus:

Classis TURBELLARIA.

I. Sub-classis *Aprocta*.

1. Ordo Dendrocœla.
2. „ Rhabdocœla.

II. Sub-classis *Proctucha*.

1. Ordo Arhynchia.
2. „ Rhynchocœla (Nemertina).

This classification has been adopted by Dr. Rud. Leuckart in the appendix to Van der Hoeven's 'Handbuch der Zoologie.'

Dr. Thomas Williams, in his 'Report on the British Annelida,' at this time[1] propounded several erroneous statements in relation to the anatomy of the Nemerteans. Thus, while correctly regarding the sacculated chamber as connected with the digestive system (though he denied the existence of an anus), he called the ganglia "hearts," and wrongly averred that the "œsophageal intestine" (proboscis) terminated in a distinct papillose outlet situated a short distance behind the cephalic extremity of the body, as in the Sipunculidæ. His attempt to prove the homology between his "closed alimentary chamber" and the spongy mass in *Tænia* rests upon no secure foundation, and does not stand the light of the correct investigations of that period or the present; and the same remark applies with respect to his grouping *Gordius* with the Nemerteans.

An interesting addition to our knowledge of the development of the group was made by Dr. W. Busch, who at this stage gave a drawing and description of a novel animal from the harbour of Trieste, on which he bestowed the name of *Alardus caudatus*.[2] This is evidently the young of a *Micrura*, and J. Müller afterwards connected its growth with that of his *Pylidium*. Dr. Busch termed the aperture of the proboscis the mouth, did not recognise the proboscis (though its position is indicated in his figure), and was puzzled by the cephalic sacs, which, as usual in the young of the Anopla, were very large.

Dr. Thos. Williams in 1852 again introduces the subject of the Nemertean "chylaqueous fluid," in his paper "On the Blood-proper and Chylaqeous Fluid of Invertebrate Animals."[3] Here he also confounds the corpuscles in the proboscidian sheath with the contents of his "alimentary cæca."

[1] 'Report of the Brit. Assoc.,' 1851, pp. 238, &c., pl. xi.

[2] 'Beobachtungen über Anat. u. Entwickelung einiger wirb. Seethiere.' Berlin, 1851, p. 111, taf. xi, f. 8.

[3] 'Philos. Transact.,' 1852, part ii, p. 627, pl. xxxii, f. 25.

During the same year (1852) Dr. Max Müller[1] gave an account of certain structures from the proboscides of an unknown *Meckelia* and *Alardus caudatus*, which he termed bacillary bodies, and some of those from the first-mentioned form contained long urticating threads. These bodies are the elements of the glandular papillæ, and I have not as yet seen such (urticating) organs in the British species, although fine processes and mucus-threads occasionally project from the summits of the papillæ under pressure.

In the zoological sketches of Dr. Max Schultze, published at this time,[2] the researches of E. Desor on development are reviewed and corrected from observations on *Nemertes olivacea*, a species which the author considers identical with Dr. Johnston's form (*Lineus gesserensis*). He also issues a very important scheme for the arrangement of the Nemerteans, which scheme is founded on the basis advanced by Dr. Johnston many years before, viz. the absence or presence of stylets in the proboscis. It is as follows:

Nemertinea.

Central nervous system consisting of two ganglia on each side, an anterior and posterior, which have two commissures, a superior and inferior, between which the proboscis passes.

Anopla.

Proboscis without stylets.

The ganglia united at their anterior border by a long and slender dorsal commissure. The lateral nerve-trunk springing from the anterior portion of the anterior ganglion, so that the posterior end is rounded. The ventral commissure common to both ganglia.

On each side of the head is a large and often very shallow furrow, having a small ciliated pit at the posterior end.

Enopla.

Proboscis with stylets.

Anterior border of the ganglia rounded. The dorsal commissure in the form of a small band between the dorsal surfaces of the ganglia. The lateral nerve-trunks forming a continuation of the posterior ganglia. The ventral commissure common to both ganglia.

The long cephalic furrow absent; but there are ciliated pits.

Though his classification is by no means complete, it certainly marks a decided advance on the schemes of his predecessors.

Few modern naturalists have done more to advance our knowledge of the habits of these unfamiliar forms than the late Sir John Graham Dalyell, whose patience and perseverance—not devoid of intuitive skill—are worthy of all praise. In the second volume of his 'Powers of the Creator' (1853),[3] he describes about twenty British species. Several of these, however, refer to different states of the same animal, but all can be readily identified with the exception of *Vermiculus crassus*. He grouped the Nemerteans under three genera, viz. fourteen under *Gordius*, five under *Vermiculus*, and one under *Planaria*. He thought they might be classified thus:—(1) Those wanting specks or eyes; (2) those where specks of an indefinite number were evidently present; (3) those with two eyes; and (4) those with four eyes. If this worthy naturalist had lived to superintend the publication of the volume, several inaccuracies which had been overlooked in his earlier notes would have been corrected, as, for instance, the remark under

[1] 'Observat. Anatom. de Vermibus quibusdam maritimis.' Berolini, 1852.
[2] 'Zeitsch. für wiss. Zool.,' Bd. iv, p. 179. 1852.
[3] 'The Powers of the Creator displayed in the Creation,' &c., vol. ii. London, 1853.

Lineus marinus, that he was not aware the animal had a proboscis, for he distinctly refers to this organ in other species. He also correctly observed the true mouth in the Anopla, since he saw the animals feeding, and recorded many interesting facts with regard to the deposition of ova. The great *Gordius fragilis* has not been procured since he found it, so far as can be ascertained. The figures in this work are executed with care, and most are coloured. R. Leuckart, in his abstract of the literature of the Turbellaria for 1858[1] furnishes the synonyms of the majority of the species described by this author.

In the same year (1853) Charles Girard gives descriptions of some new Nemerteans from the coasts of the Carolinas, for which he establishes several genera.[2] He interprets the true mouth in the Anopla as the aperture of the generative system, while he terms the proboscidian aperture the mouth. The description of his *Stimpsonia,* as it appears in this paper, differs from *Bipalium* in several important particulars.

Dr. Thomas Williams[3] likewise published, in 1853, an account of the method of aquatic respiration in invertebrate animals, and specially refers to the "Nemertidæ" as having the whole of the digestive chamber filled with a corpuscular fluid, which, he states, carries out this important function. He shows a drawing of the alimentary system of a species named *Nemertes camillæ,* which may be synonymous either with *N. gracilis* or *N. Neesii,* probably the former. He still erroneously places the anus towards the anterior end, and avers that the organization of the "Nemertine Annelida" conforms in every essential particular to that of the Cestoid Entozoa.

Next year C. Gegenbaur[4] mentions that he frequently found *Pylidium gyrans* at Messina, and gives remarks on its structure. From his description it would appear that he found the Nemertean *Pylidium,* but did not quite interpret its full relationship. He noticed that it differed from the Echinoderm-*Pylidium,* and at first thought that the whitish oval body in its interior had been swallowed, but the occurrence of others of the same species convinced him of the connection between the two.

In his 'Archiv' for 1854 J. Müller adds still further to our information on the development of the Nemertean *Pylidium.*[5] He recognises the identity of the contained body with the *Alardus caudatus* of Dr. Busch, and gives a somewhat better figure of the worm, with a normal arrangement of the caudal process; and his remarks on its structure are likewise more correct. He mentions the fact that *Micrura fasciolata,* Ehrenberg, has a terminal process, but does not state the identity of the two, since his young form possesses only two eyes, whereas the former has ten. In this paper he also notes certain experiments with hot water which he performed on *Meckelia somatotomus,* Leuckart.

Dr. E. Grube,[6] in his introductory remarks on the Nemerteans (in 1855), criticises the interpretations of the proboscis adopted by M. de Quatrefages, and points out that the true digestive apparatus lies below the former, each system opening by a definite aperture in the snout of the Anopla. He thought it probable that the Nemerteans used the proboscis after the manner of

[1] 'Archiv für Naturges.,' 1859, pp. 187 and 188.

[2] 'Proceed. Acad. Nat. Sc. Philadelphia,' vol. vi, 1853, pp. 365-367.

[3] 'Ann. Nat. Hist.,' 2nd ser., vol. xii, pp. 341, &c., plate xiii, figs. 1 and 2.

[4] 'Zeitsch. für wiss. Zool.,' Bd. v, 1854, p. 345.

[5] 'Archiv für Anat.,' 1854, pp. 75—84, taf. 4, f. 2—8.

[6] "Bemerkungen über einige Helminthen u. Meerwürmer," 'Archiv für Naturges.,' 1855, pp. 145—152, taf. 7, f. 1—4.

the elephant, viz. for squirting fluid containing prey into their mouths. In this paper several species are described, viz. (1) *Meckelia annulata,* the greenish form with white stripes previously mentioned, which, if it had a terminal process, would be closely allied to *Micrura fasciolata.* (2) *Meckelia aurantiaca,* a species (of Micrura) with a caudal process. (3) *Ophiocephalus auripunctatus,* one of the Anopla. (4) *Nemertes purpurea,* Johnst., probably a reddish variety of *Lineus gesserensis.* (5) *Nemertes lactea,* a species intimately connected with the *Lineus lacteus* of Montagu.

In the same year (1855) W. Stimpson[1] gave descriptions of some Nemerteans from the China, Japan, and other seas. He considered the mouth to be the genital fissure. Two of his species, viz. *Valencinia annulata* and *Meckelia olivacea,* seem to be identical with those found in Britain, at least so far as one can judge from descriptions. External characters are chiefly relied on, and the accounts of the species are comparatively meagre.

Dr. J. E. Gray,[2] in 1857, made a few remarks on a large *Lineus,* which he had received from Mr. Beattie, of Montrose. He correctly called the longitudinal slit the mouth, and provisionally termed the animal *L. Beattiæi.* Four lithographic figures are given in the plate connected with this paper, the three upper from the ventral surface of the snout in various degrees of contraction, and the fourth a side view in semi-contraction. The preparation in the British Museum is labelled by Dr. Baird "*Serpentaria fragilis,*" and in all probability he is correct. It is a very large specimen, although fragmentary.

In the 'Icones Zootomicæ' of Carus, Dr. Max Schultze contributes a paper on the structure of the Nemerteans, chiefly of *Tetrastemma obscurum.*[3] He supplies no definite account of the floor of the anterior chamber of the proboscis, or of the stylet-region, and the structure of the latter is not advanced in detail beyond his previous description. The marginal stylets are still termed reserve-stylets. No œsophageal division of the digestive tract is shown. He has endeavoured to reconcile his older and incomplete representation of the circulatory system with modern views by carrying the lateral trunks (which, in his previous figure, resembled the pale border of the proboscidian sheath) into the snout, and introducing a central vessel from end to end. As might be expected under the circumstances, however, some confusion occurs; thus, the central vessel is carried forward in the snout in front of the ganglia to the middle of the arch, instead of sending off the anastomotic behind the ganglia to join the lateral vessels. The arrangement of his water-vascular system is something quite different from anything seen in our examples. In his former delineation I considered he had mistaken the ordinary blood-vessels for a water-vascular system, but now, since he has put in the three main trunks as an entirely distinct series, our decision is the more accurate. The author is somewhat confused in this matter. He gives two new figures, one of which (*Tetrastemma*) correctly indicates the proboscidian bodies in the interior of the proboscidian sheath, while the other is by no means a characteristic figure of *Lineus gesserensis,* inside a sheath of ova.

Mr. Beattie,[4] without reference to the Nemertean previously sent to Dr. Gray, goes on, in the 'Proceedings of the Zoological Society' for 1858, to relate that he had received a very long

[1] 'Proceed. Acad. Nat. Sc., Philadelphia,' vol. vii, pp. 381 and 389. 1855.
[2] 'Proceed. Zool. Soc.,' part xxv, 1857, p. 210, Annulosa, pl. 47.
[3] 'Icones Zootomicæ,' J. V. Carus, part i, tab. 8, f. 10—15. Leipzig, 1857.
[4] 'Proceed. Zool. Soc.,' part xxvi, 1858, p. 307.

example of *Lineus longissimus*, which after four days' captivity produced a cream-coloured young one 18 inches long, and about two thirds of a line or $\frac{1}{18}$th of an inch in diameter. This "young animal" lived about a week after its expulsion. Dr. Gray adds that Dr. Baird had examined the specimen produced, and thinks it very probably the true offspring of the Nemertes. An examination in the British Museum shows that the "young animal," or "tubus cibarius," as the latter lamented observer afterwards named it, is the proboscis, probably, of *Cerebratulus angulatus*.

In the 'Archiv für Anatomie' for the same year, Dr. A. Krohn[1] repeats and confirms Müller's observations on the Nemertean *Pylidium*, and it may be mentioned that this author independently discovered the connection of the structure with a Turbellarian in 1851. The editor (J. Müller) appends a note to this paper, stating that *Micrura* of Ehrenberg is identical with *Alardus*, Busch, and he gives a list with the synonyms of four species of *Micrura*.

An elaborate article on the Nemertean *Pylidium* subsequently appeared in the same volume of the 'Archiv' (1858) by Leuckart and Pagenstecher, who found two species at Heligoland, viz. *P. gyrans* of Müller, and another which they termed *P. auriculatum*.[2] They traced most minutely the development and relations of the various organs in the embryo of *P. gyrans* (one of the Anopla), but the origin of the *Pylidium* itself had hitherto escaped notice. Their species had no style or caudal process after extrusion. Two eyes are developed before the worm separates from the *Pylidium*. Their account was the best on the subject until the appearance of E. Metschnikoff's recent paper.

In the same year (1858) W. Stimpson gave in his 'Prodromus' a list, with brief descriptions, of the Nemerteans collected in the United States' expedition to the Northern Pacific, and grouped his species under old and new genera, which were arranged to suit the views of the author. His classification is as follows:—

A. A ventral aperture situated under the head or neck. No eyes.

- *a.* Lateral fissures on the sides of the head.
    - 1. Body of the ordinary form.

Under this group he places *Lineus*, Sowerby, *Cerebratulus*, Renier, *Meckelia*, Auct. limit., and *Serpentaria*. The statement concerning the absence of eyes is erroneous.

-
    - 2. Body rolled at the edges.—*Diplopleura*.
- *b.* No lateral fissures.
    - 1. Proboscidian aperture terminal.—*Tæniosoma*, n. g.
    - 2. Proboscidian aperture subterminal.—*Valencinia*.

B. No ventral aperture. Eyes two or many.

- *a.* Fissures or furrows at the margins of the head.—*Dichilus*, n. g., *Tetrastemma*, Hemp. and Ehrenb., *Cephalonema*, n. g., *Emplectonema*.
- *b.* Without pits or furrows.
    - 1. Eyes two.—*Diplomma*, *Dicelis*, n. g., *Polystemma*, Hemp. and Ehrenb., *Polina*, n. g., *Tatsnoskia*, *Cosmocephala*.

[1] 'Archiv für Anat.,' 1858, pp. 289—293.
[2] 'Archiv für Anat.,' 1858, pp. 569—587, taf. 19.

By his first great division, based on the presence or absence of the ventral aperture (by which he probably means the mouth), the Enopla are in a rough way separated from the Anopla, but the classification, being founded on external characters, fails just where it is most wanted. The author considerably extends the limits of the known species, and gives an interesting chronological list of the genera.[1]

Dr. E. Graeffe[2] next furnishes an account of a yellowish-green *Tetrastemma* from Nice, which is remarkable in having lenses to its eyes, and in possessing what he terms otolithes. The presence of the latter organs, if no misconception occurred, is something very different from anything seen by us in the British Nemerteans, but is analogous to the otolithes described by several authors in other invertebrates, such as the Mollusca.

Dr. Thomas Williams, in a morphological paper, published in 1858, committed some serious errors in his interpretation of the Nemertean generative organs, which, he said, coincided in shape, place, and structure, with the ovarian or female series of the Hirudinei.[3] Moreover, he asserted that they corresponded in number not with the cæca of the alimentary canal, but with the annuli of the body, a statement requiring some further proof, since it is very doubtful if the term annuli can be used in any sense with respect to the Nemertean body, which is not in truth segmented. His representation of the ovaria or female segmental organs in *Polia quadrioculata* is imaginary, for the organs are reversed, made bifid at one end, and filled with minute cells,—conditions at variance with nature. He thought that the Nemerteans should be separated from the Planarians by a very wide interval; indeed, he affirmed that they had only one character in common, viz. the ciliated integument. This cannot be supported in the sense he means, though the gap between the two is by no means narrow.

Gegenbaur[4] the following year arranged the Nemerteans under the sub-class *Platyelminthes*, order 3, *Turbellaria Rhynchocœla*. He followed De Quatrefages in regard to the general anatomy of the animals.

Schmarda at this time described many foreign Nemerteans, which he had collected during his voyages, in a finely illustrated work.[5] He divided the order *Nemertinea* into two sub-orders—based on the absence or presence of the "respiratory organs," and termed respectively *Abranchiata* and *Rhochmobranchiata*. The former he portions into families according to the shape of the head; the latter is similarly divided, in conformity with the number of the supposed branchial furrows or fissures. He gave the opinion, in his introduction, that the structure of the stylet-region of the proboscis might be of service in classifying the smaller species, but was utterly useless in the larger forms, and those preserved in museums, hence he was obliged to take the former mode of discrimination. But it is impossible to study such animals with any degree of accuracy as spirit-preparations, without first having investigated them as living subjects. It is unnecessary to give

[1] "Prodromus descriptionis Animalium Evertebratorum, quæ in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa," &c., part ii, *Turbellarieorum Nemertineorum*; 'Proceed. Acad. Nat. Sc.,' Philadelphia, 1858, pp. 159—165.

[2] 'Beobachtungen über Radiaten u. Würmer in Nizza,' pp. 53 and 54. Zurich, 1858.

[3] "On the Structure and Homology of the Reproductive Organs of the Annelids," 'Philos. Trans.,' 1858, pp. 131—132, pl. 8, f. 24.

[4] 'Grundzüge der Vergleichenden Anatomie.' Leipzig, 1859.

[5] 'Neue Turbell., Rotat. u. Anneliden beobachtet u. gesammelt auf einer Reise um die Erde, 1853 bis 1857,' i, 1; Introd., pp. xiii and xiv, and pp. 40—46. taf. 9—11. Leipzig, 1859.

minute details of the classification, since it appears to be little else than a confused grouping. In the first place, it has not yet been proved that these furrows and fissures are branchial; secondly, the locating in the family *Holocephala* genera so widely divergent as *Valencinia*, De Quatrefages, and *Ommatoplea*, Ehrenberg, the arranging under two different sub-orders of the closely allied forms *Œrstedia* and *Tetrastemma*, and the statement that in *Micrura* the head is furnished with a single terminal transverse fissure, are certainly sufficient to shake our faith in the author's knowledge of the subject.

An interesting contribution to the anatomy and zoology of the Turbellaria was published by M. van Beneden in 1860,[1] the Nemerteans occupying the first part of the memoir. He correctly observed the apertures of the generative organs along the sides, but erroneously considered that the proboscis floated in the general cavity of the body. He had good reasons for supposing that the coat of the digestive tract combined the functions of the liver as well as an alimentary organ proper. His anatomy of the cephalic sacs in the Anopla was inaccurate. He discovered that some of the embryos in *Nemertes communis* were ciliated in the ova before laying; and his observations on the development of *Polia involuta* (*Nemertes carcinophila*, Kölliker), form the most valuable portion of the memoir, though he was wrong in supposing that one form was evolved out of the other, like a *scolex* engendering a *proglottis*. He also made the mistake of placing the mouth of the Enopla (ex. *Polia obscura*) behind the ganglia, instead of in front of them. His memoir is illustrated by four lithographic plates, some of the figures being coloured.

E. Claparède, in his remarks on *Tetrastemma varicolor*, Œrst., and another from Skye,[2] in 1861, clearly pointed out the duct to the marginal stylet-sacs. He considered the latter to be the receptacles for stylets rejected from the central apparatus, and he combated the contrary view held by Max Schultze. While he observed the cavity of the reservoir, he fell into the error of calling the posterior chamber the muscular retractor of the organ. He also notes the form of the papillæ in the proboscis of *Cephalothrix lineata*.

In 1862 Diesing produced a 'Revision' of the *Turbellaria*,[3] the Nemerteans being placed under the second Tribe *Rhynchocœla*, some of them occurring after the Families *Rhynchoscolecidea* and *Gyratricina* in his sub-tribe *Rhynchocœla Aporocephala*, and the rest under a second sub-tribe *R. Porocephala*. The former contains the families *Borlasiea*, *Ommatophora*, *Micrurea*, *Hypoloba*, and *Acroloba*; the latter *Prorhynchidæ*, *Emeidea*, *Typhlonemertinea*, *Loxorrhochmidea* and *Eunemertinea*. The confusion and errors in this *brochure* are not fewer than in the preceding, and render it almost beyond the pale of criticism.

The most important and at the same time the most recent publication of note on the Nemerteans is that of Professor Keferstein, from observations made at St. Vaast-la-Hougue.[4] It will be necessary to enter somewhat minutely into this contribution, which marks another era in Nemertean literature. He first treats of their classification as follows:—

[1] 'Recherches sur la Faune Littorale de Belgique,' extrait du tome xxxii des 'Mémoires de l'Académie Royale des Sciences de Belgique,' 1860.

[2] 'Recherches Anat. sur les Anélides, Turbellariés, &c., observés dans les Hébrides.' Genève, 1861.

[3] "Revision der Turbellarien, Abtheilung Rhabdocœlen." 'Sitzungsb. d. Kais. Akad. d. wissensch. Wien.,' 1862, pp. 199—204 and 247—306.

[4] 'Zeitsch. für wiss. Zool.,' Bd. xii, pp. 51—90, taf. 5—7, 1862.

Order.—NEMERTINEA.

Sub-order I.—Nemertinea enopla, *Max Schultze.*

Proboscis furnished with a stylet-apparatus.

Fam. 1.—Tremacephalidæ.

The fissures of the head short, of a transverse (linear) form, or funnel-shaped. Brain with the superior ganglion less elongated than the inferior, and separated by an almost free border from the latter; the lateral nerve springing from the posterior end of the inferior ganglion, or almost a continuation thereof.

(a) *Tremacephalidæ* without the lobe-shaped front of the head.

Gen. 1. *Polia,* Delle Chiaje, 1825. Head easily distinguished from the body, narrowed anteriorly, without eyes. Mouth near the anterior end. Body diminished posteriorly.

Gen. 2. *Borlasia,* Oken (char. reform.). Head not distinguished from the body, mostly with eyes. Mouth in some removed the breadth of the head from the anterior end. Body less diminished posteriorly, and generally somewhat short.

Gen. 3. *Œrstedia,* Quatref., 1846. Head not distinguished from the body; lateral nerves coursing near the median line, not, as generally, entirely confined to the sides.

(b) *Tremacephalidæ* with the lobe-shaped head anteriorly.

Gen. 4. *Micrura,* Ehrenberg, 1831. Head not distinguished from the body; anteriorly with a transverse fissure, so as to form an upper and under lip, between which the proboscis emerges. With eyes. Mouth situated about the breadth of the head from the anterior end.

Gen. 5. *Prosorhochmus,* gen. nov. Head not distinguished from the body, snout with three lobes, the anterior border being heart-shaped, with the third lobe placed dorsally (over the notch). The track of the proboscis separates the inferior lobes anteriorly. With eyes. Mouth placed a pair of head-breadths from the anterior end. Body moderately long and contractile.

Gen. 6. *Lobilabrum,* Blainville, 1828. Head not distinguished from the body, anterior end with four lobes; this anterior end is separated into an upper and a lower lip, between which the proboscis passes; and, again, the border is heart-shaped (emarginate), the upper more deeply than the under, so that it seems to be provided with two tentacula.

Sub-order II.—Nemertinea anopla, *Max Schultze.*

Proboscis not supplied with a stylet-apparatus.

Fam. 2.—Rhochmocephalidæ.

The cephalic fissures are long, and occupy the entire side of the head. Brain with the upper ganglion covering the inferior completely; the lateral nerve springing from the side of the inferior ganglion in front of its posterior and pointed ending.

(A) *Rhochmocephalidæ* without the lobe-shaped snout.

Gen. 7. *Lineus,* Sowerby, 1804. Head easily distinguished from the body, somewhat broad. Mostly without eyes. Cephalic fissures extending to the mouth. Posterior part of body almost pointed, flat, very long and contractile, sometimes knotted.

Gen. 8.—*Cerebratulus,* Renier, 1807. Head not distinguished from the body, somewhat smaller, but ending bluntly. Cephalic fissures extending to the mouth. Body not smaller towards the posterior end, flat, moderately long and slightly contractile.

Gen. 9.—*Nemertes,* Cuv. (char. reform). Head not distinguished from the body. Cephalic fissures long, extending to the mouth. Mostly with eyes. Body flat, moderately long and contractile.

(B)—*Rhochmocephalidæ* with the lobe-shaped snout.

Gen. 10.—*Ophiocephalus,* Delle Chiaje, 1829. Head distinguished from the body, somewhat smaller, but ending bluntly, the snout having a deep median groove on the dorsal and ventral surfaces, so that it appears bilobed. Cephalic fissures long, extending to the mouth. No eyes. Body long.

Fam. 3.—GYMNOCEPHALIDÆ.

The cephalic fissures entirely lost. Brain like that in *Polia,* but the superior ganglion covers the inferior much less. The lateral nerve proceeds from the entire side of the inferior ganglion, or is almost a continuation thereof.

Gen. 11.—*Cephalothrix,* Œrsted, 1844. Head not distinguished from the body, very long and pointed. The mouth lies more than the breadth of a head from the anterior end. Body rounded, very long, filiform, and very contractile.

No fault can be found with the primary subdivisions or sub-orders (after Max Schultze), and the family-name *Tremacephalidæ,* as applied to the *Amphiporini,* is not seriously wrong, but the sub-families and genera of this portion require complete reformation. His criterion of the "absence of the lobe-shaped snout" does not stand the author in good stead if we may judge from the genera he has thrown together in the sub-family. The first of his genera (*Polia*) seems to me to be in a questionable position, since the Nemertean described by Delle Chiaje under the name of *Polia siphunculus* is, so far as I can make out, one of the Anopla. The second genus, *Borlasia,* has a very unfortunate name; for, while I agree with the author as to the propriety of preserving the title commemorative of the early English naturalist, it certainly ought not to be bestowed on a group of Nemerteans totally different in structure from that form (*Lineus marinus*) to which the name was originally given by Oken. The author has simply followed De Quatrefages in the formation of the third genus *Œrstedia,* the anatomy of which, especially the position of the nerve-trunks, differs in no respect from the type of the Enopla. A still more serious error has been committed with the fourth genus, *Micrura,* this being a true member of the Anopla, and having no connection with *Tetrastemma,* Ehrenberg, or other representative of the Enopla. The fifth genus, *Prosorhochmus,* may be allowed to stand, as descriptive of a curious example of the Enopla, closely allied to *Tetrastemma,* discovered by the author. The sixth genus, *Lobilabrum,* was constituted by De Blainville for a form pertaining to the Anopla, and, therefore, is quite out of place in its present position. There are, perhaps, fewer errors of commission in his second sub-order (*Nemertinea Anopla*), though his description of the family requires some additions, and the application of the test of the "lobe-shaped snout" is of no moment. The genus *Lineus* is good, but *Cerebratulus*, the next or eighth genus, requires further examination. The ninth genus, *Nemertes*, seems quite superfluous, for the *Notospermus drepanensis* of Huschke will fall under other genera. It appears to be an example of the Anopla. The tenth genus, *Ophiocephalus*, is also very much open to doubt, since the *Ophyocephalus murenoides* of Delle Chiaje may be a variety of *Lineus marinus*. His third family (*Gymnocephalidæ*) is certainly worthy of separation, and the sole genus, *Cephalothrix*, is satisfactory.

The second part of his memoir is occupied with a description of several species. Amongst these, his *Borlasia splendida*, n.s., is the *Cerebratulus spectabilis* of De Quatrefages; *Nemertes octoculata*, n.s., had often been described before; while *Cephalothrix ocellata*, n.s., and *C. longissima*, n.s., may conveniently, as well as correctly, be included under the well-known form *Cephalothrix linearis*.

The third division is devoted to the anatomy of the group. He did not recognise the differences existing in the muscular system of the body-wall of the various types; the position of the mouth in the Enopla was misunderstood; and he had no correct knowledge of the true relations of the muscular sheath of the proboscis, or of the minute anatomy of the wall of the latter. He did not discriminate with sufficient accuracy the cephalic sacs and the posterior ending of the ganglia in *Lineus*. While the author went astray in these and several other anatomical points, he made advances of considerable interest in others, so that his paper is a valuable and most praiseworthy contribution on the Nemerteans. Keferstein's classification, with all its imperfections (and a few superadded), has been adopted by J. V. Carus in his 'Handbuch der Zoologie.'

Diesing now issued a third *brochure* on the subject,[1] bringing the literature up to the time; but he did not alter his arrangement, except when introducing "new" genera, many of which, however, had previously appeared in his publications. On the whole, the labours of the writer have chiefly been of value in rendering us acquainted with the various papers relating to the Nemerteans; and it will be the safest course for the investigator simply to regard these works in this light, and to remember that the author had the disadvantage of being unacquainted with the living animals, and strove to be of use to science even when attacked by a great misfortune.

E. Claparède, in a memoir[2] published shortly after Keferstein's, makes some further remarks on *Prosorhochmus Claparedii*. He mentions that he had seen ova in the body of the adult worm, and doubts the correctness of Professor Keferstein's statement, that he had found three stylet-sacs in a young specimen, since there are only two in this and other Nemerteans. He also describes a new species of *Tetrastemma*, viz., *T. marmoratum*, which, however, is only the *T. dorsalis* of Abildgaard; and, lastly, he adds a note on *Œrstedia pallida*. His observations were made on the coast of Normandy.

In the following year, Dr. Cobbold[3] did not hesitate to place the *Turbellaria* amongst the Sterelmintha; yet I am unable to find out any sound reasons in his description for this grouping, to which I am inclined to object. He arranges them as the first order, *Turbellaria*, under the

[1] 'Nachträge zur Revision der Turbellarien.' Sitzungsb. d. Kais. Akad. d. wissensch. Wien, 1863 (46 Bd.), p. 5.

[2] 'Beobachtungen über Anat. u. Entwicklung. wirb. Thiere,' &c., pp. 23 and 24, taf. v, f. 10—14. Leipzig, 1863.

[3] 'Entozoa: An Introduction to the Study of Helminthology,' &c., chap. i. London, 1864.

first sub-class of his Helminths (Sterelmintha), the second order being the *Trematoda*. He states that "the *Turbellaria* come nearer to the Trematoda than they do to the Suctorial Annelids, which latter, be it remembered, are furnished with a complete intestinal tube and anus; and, moreover, their characters, by the intervention of the Planarians, are too closely linked on to the Trematoda to permit their being elevated by themselves into a separate class." He divides the *Turbellaria* into two families, *Planariadæ* and *Nemertidæ*. Further, "in common with the *Trematoda*, the Turbellarians have their bodies composed of soft parenchymatous tissue, and in this loose substance the various specialized organs are lodged, without the intervention of any perivisceral cavity. Some of the animals have a flattened form, others are cylindrical, while a third kind are remarkably attenuated, and more or less barred by transverse rugæ, which form, as it were, a series of spurious joints or articulations. The mouth and digestive apparatus are well developed, but there is no certain evidence as to the existence of an anus in any of the species." It is not the case that the Turbellarians (any more than the Flukes) have their bodies composed of "soft parenchymatous tissue," for their cutaneous and muscular systems are highly developed and differentiated; and, while the Planarians are no doubt allied in external form, and in the branched condition of their digestive system, to the Trematoda, yet they are still more closely connected with the Nemerteans, which diverge so much from any parasitic worm recorded by this or any other author. With as much reason, I fear, we might place *Sagitta* amongst fishes, and *Amphioxus* amongst worms, as assert that "the Nemertidæ very closely resemble the common tapeworms, or Cestodes, properly so-called—not only by their band-like forms, but more particularly by their tendency to display transverse rugæ, which, as before remarked, acquire a certain degree of regularity." His observations on the anatomy of the Nemerteans are behind date; and in the recent 'Supplement'[1] he seems to have avoided the subject altogether. From what I have seen of the structure of the Flukes and Tapeworms, there would appear to be a considerable margin left for the minute anatomical investigators of the future.[2]

The Nemerteans are placed by Dr. Johnston, in the 'Catalogue of the British Museum,' under Ehrenbergs order *Turbellaria*, forming the second sub-order *Teretularia* of De Blainville.[3] Considerable errors still remain in the author's views as to the structure of the group; thus the mouth is stated to be terminal, and to give passage to the proboscis; while the anus is said to open well forward on the ventral surface in some, and in others at the posterior extremity. The mouth in the Anopla is called a genital orifice. Little is added to the information previously published by the author or others up to the time of his lamented death; and thus the work is thrown far behind date. His two genera, *Cephalothrix* and *Astemma*, are synonymous, while the others pertaining to the Enopla and Anopla are so mixed up that the value of the work is greatly impaired. Several species are described more than once under different names. Still further confusion is propagated in the Appendix by the observations, under the general characters of the *Teretularia*, that there is no anus; that there are two hearts; and that the female aperture (often mistaken for a mouth) is situated, "sometimes below the head, sometimes large and sucker-like, sometimes posterior and nearly terminal, when it has been mistaken for an

[1] London, 1869.

[2] The recent paper on the latter group by Professors Sommer and Landois bears out the above remark, which was penned more than three years ago. See 'Zeitsch. f. wiss. Zool.' for March, 1872.

[3] 'A Catalogue of the British Non-Parasitical Worms in the Collection of the British Museum.' London, 1865.

anus." The early structural observations of Dr. Johnston are also reprinted from 'Loudon's Magazine,' the 'Magazine of Zoology and Botany,' &c., with the plates, and quotations made from the work of Sir J. Dalyell. It would not be just to state that this treatise advances British science; but much must be overlooked in the circumstances of its publication. Its value chiefly lies in being the only English work on the subject.

Dr. Baird, in the 'Proceedings of the Zoological Society for 1866,'[1] gives an account of a new species of Monœcious worm, which is evidently one of the Anopla allied to the *Gordius fragilis* of Sir J. Dalyell (*Cerebratulus angulatus*), with the margins of the body produced as in the swimming forms. The author stated that the ventral slit led into the "visceral cavity," and agreed with many others in regarding the proboscis as the alimentary canal, and its aperture in front, the mouth.

The observations of Mr. Alex. Agassiz[2] carry those of the experienced Prof. Lovén[3] a stage further with respect to the development of a curious larva, which the former regards as Nemertean. The most remarkable feature is the discovery of a kind of retrograde metamorphosis which the young animal undergoes, whereby it loses its segmented form and its tentacles, and assumes the simple outline (but not the structure) of a Nemertean. Further remarks on this interesting communication will be found elsewhere.

In 1867 the author published a short paper on the Gregariniform Parasite of Borlasia.[4] The occurrence of this parasite was observed in several species, together with certain other parasitic ova in gelatinous mucus, which occupied the alimentary tract of the worms. Pseudo-navicellæ were also mentioned. Various notes were further communicated in the author's Reports to the British Association.[5]

Professor Keferstein in 1868 made known the singular fact that, in one of the Enopla from St. Malo, he had found the anterior generative sacs filled with spermatozoa, and the posterior with ova; thus establishing the occurrence of hermaphroditism in this formerly diœcious group.[6] A F. Marion, the following year, observed the same fact, also in one of the Enopla—from deep water off Marseilles.[7] This species had four eyes, each furnished with lenses; and it differed from that described by Keferstein further in not having the male and female organs arranged in separate parts of the body.

In the same year, a paper on the reproduction of lost parts in the Nemerteans was communicated by the author to the Linnean Society.[8] In this it was shown that each of the fragments into which *Lineus sanguineus* breaks becomes a perfect animal. Allusion was also made to the curious manifestation of acidity presented by the majority of the Nemerteans, and a few exceptions noted in a paper on the boring of the Annelids.[9]

[1] 'Proceed. Zool. Soc.,' Feb. 13, 1866.

[2] "On the Young Stages of a few Annelids," 'Ann. Lyce. Nat. Hist. N. York,' vol. viii, June, 1866; and 'Ann. Nat. Hist.,' 3rd ser., vol. xix, p. 208.

[3] 'Ann des sc. nat.,' sér. 2, xviii, p. 288. 1848.

[4] 'Journ. Micros. Sc.,' vol. xv, n. s., Trans., p. 38, pl. ii. April, 1867.

[5] 'Rept. Brit. Assoc.,' 1867, p. 92; and 'Rept. Brit. Assoc.,' 1868, p. 340.

[6] 'Archiv für Naturges.,' 1868, p. 102, taf. 3, f. 1 and 2; and 'Ann. Nat. Hist.,' ser. 4, vol. i, p. 229.

[7] 'Ann. Nat. Hist.,' ser. 4, vol. iv, p. 136.

[8] 'Proceed. Linn. Soc.,' Zool., vol. x, pp. 251—253, tab. 7.

[9] 'Ann. Nat. Hist.,' ser. 4, vol. ii, p. 293.

In 1869 a memoir was published by the author on the anatomy of the British Nemerteans (communicated to the Royal Society, Edinburgh, in April, 1868), in which many facts were recorded, it is believed, for the first time.[1] Their minute structure, from the skin to the proboscis, was described, the chief varieties indicated, and observations on the development of a few species appended. In this year also the outlines of a classification, founded on anatomical data, were brought under the notice of the same society.[2]

Excellent researches, by Dr. Elias Metschnikoff, on the development of the Nemertean *Pylidium*, from the deposition of the ovum from which the latter is evolved onwards, have recently appeared.[3] His observations were made on the ova of an elongated, whitish example of the Anopla at Messina, and on a species of *Pylidium* from Odessa; and his paper is illustrated by finely executed steel engravings. The chief details will be found under the head of the development of the Anopla, and therefore need not be further alluded to at present. In his summary many suggestive comparisons are drawn between the development of the Nemertean *Pylidium* and the well-known phases in the growth of the Tapeworms.

The veteran naturalist, Professor E. Grube, in his most interesting *brochure*,[4] recently published, on the marine fauna of St. Vaast-la-Hougue, refers to certain common Nemerteans found there. He observes that his boatman stated that the head of *Lineus marinus* was luminous, but this he did not personally witness. He also notices a blood-red flat worm, *Proceros sanguinolentus*, Qfg., with cephalic furrows.

A few notes on the Nemerteans are appended to a paper by Professor Ehlers "On the Vermes collected in the Sea of Spitzbergen."[5] Three new species are described from spirit-preparations, but this is a somewhat unsatisfactory mode of examination, unless careful accounts are kept of the animals in life.

[1] 'Trans. Roy. Soc. Edinb.,' vol. xxv, ii, pp. 305—406, pls. iv—xiv.

[2] 'Proceed. Roy. Soc. Edinb.,' vol. vi, pp. 545—548.

[3] 'Mém. de l'Acad. Imp. des Sc. de St. Pétersbourg,' vii^{e} sér., tom. xiv, no. 8, 1869.

[4] 'Mittheilungen über St. Vaast-la-Hougue u. s. Meeres-, besonders s. Annelidenfauna.'

[5] 'Ann. Nat. Hist.,' 4th ser., vol. viii, p. 60. Transl. from the 'Sitzungsb. der phys.-medic. Soc. zu Erlangen.,' June 7, 1871.

ANATOMY AND PHYSIOLOGY.[1]

General Conception, or Archetype of a Nemertean.

Fig. 1.

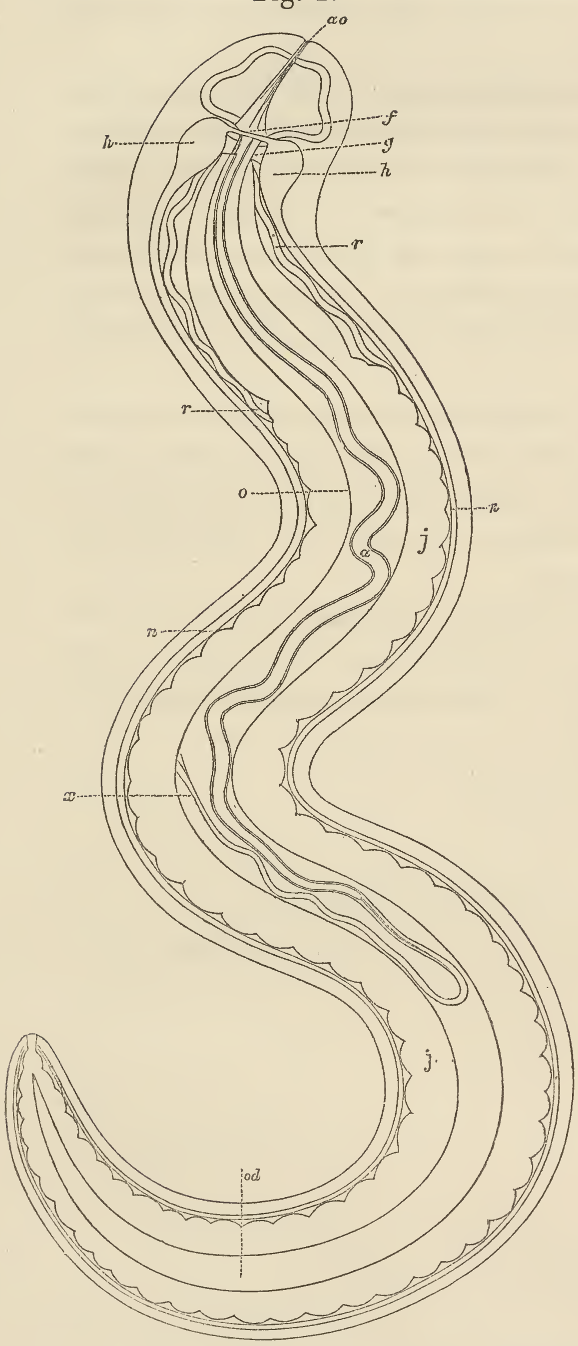
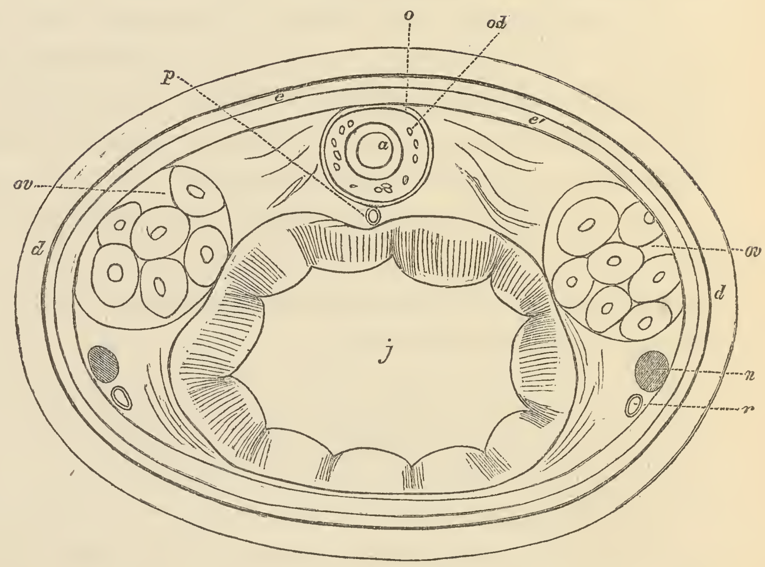


Fig. 2.



ARCHETYPE OF A NEMERTEAN.

FIG. 1. In its ordinary condition. FIG. 2. In transverse section.

a. Proboscis. *ao.* Aperture in snout for proboscis. *d.* Cutis *en masse.* *e* and *é.* Muscular coats of the body-wall. *f.* Superior commissure. *g.* Inferior commissure. *h.* Ganglia. *j.* Digestive chamber. *n.* Lateral nerves. *o.* Muscular sheath for proboscis. *od.* Proboscidian chamber containing corpuscles. *p.* Dorsal blood-vessel. *r.* Lateral blood-vessels. *ov.* Ovaries. *x.* Muscular ribbons.

[1] A description of the anatomy of the group was published by the author in the 'Transactions of the Royal Society of Edinburgh' (vol. xxv); but so many additions, both in text and drawings, were necessary, that this could not be allowed to stand. Accordingly the whole has been rearranged.

The essential character or archetype of a Nemertean may be thus described:—A soft vermiform body, covered with cilia, and furnished with a thick glandular cutis, beneath which the body-wall is composed of several strong, specially disposed muscular layers. Through the centre of the body-cavity (and entirely beneath the nerve-commissures in front) passes the digestive canal, which has two well marked divisions, an oral aperture anteriorly, and an anal posteriorly, and is richly ciliated throughout. The nervous system consists of two conspicuous cephalic ganglia, united by a double commissure, and giving off posteriorly a large lateral nerve-trunk, which passes backwards on each side to the tail. The circulatory system is composed of a series of closed contractile vessels. Along the median line of the dorsum lies a special muscular sheath, containing a complicated proboscis, and a highly organized corpuscular fluid, both the sheath and the proboscis passing between the commissures of the ganglia in front. The sexual organs are in the form of sacs, placed between the muscular wall of the body and the digestive canal.

I.—Anatomy of the Enopla.

1. *Cutaneous System.*

The body of every example of the order is universally covered with cilia, the motion of which may be very well observed in some of the larger forms by placing them in good light under a lens. The proboscidian aperture, the mouth, and the tip of the tail, are generally furnished with longer cilia. The ciliary motion is most active in the cephalic furrows of this group.

In *Amphiporus lactifloreus* the skin is somewhat opaque, and presents a cellular, or cellulo-granular appearance (Plate X, fig. 6), the entire field being definitely covered with glandular cells, and the reddish pigment, when present, grouped in irregular granular masses. I have not been able to demonstrate the cuticle as a separate structure, on account of the softness and delicacy of the tissues. On removing a portion of skin from a living specimen, and placing it under moderate pressure, it presents the aspect of a series of ovate or spathulate cells (Plate X, fig. 5), which contain soft and minutely granular contents, interspersed with large, clear masses of mucous or gelatinous matter, having a similar figure, the latter becoming more abundant as the pressure increases. There are also numerous pigment- and other granules scattered over the field. Changes, however, rapidly ensue under pressure, and the contents of the cuticular spaces or areolæ pass rapidly to the nearest free border, and there accumulate as mucous and granular circular masses (Plate X, fig. 7 *a*, *b*). A transparent gelatinous basis-substance, having a reticulated aspect, remains after the extrusion of the foregoing elements from the skin.

When a transverse section is made of the integument, after hardening in spirit and mounting in chloride of calcium, the appearance (Plate X, fig. 4) is as follows:—In rapidly prepared and newly fitted specimens, a structureless mucous film is sometimes observed to separate from the exterior of the skin, as indicated by the double outline at the edge of the figure. Chloride of calcium dissolves this; and it has not been seen in those hardened in chromic acid. This is not an epiderm, but only an exudation of transparent mucus, and it is also observed in the living animal under pressure. The areolar cutis (*a*) is now much altered, and streaked perpendicularly, an appearance due to the collapsed condition of the spaces, the contents of which to a greater or less degree have escaped, and thus greater prominence is given to the hyaline intercellular substance. It is granular throughout, especially towards the outer and inner edges. In many transverse sections, pressure of the thin glass cover causes a change in each of the preparations, so that the more cellular appearance of the outer edge is partly due to the fact that the texture is seen from without, and not laterally. Towards the inner edge, the skin in this state sometimes assumes a crenate aspect, and adjoins a pale and structureless basis-layer (*b*), which separates it from the subjacent muscular walls of the body. In longitudinal sections of the textures, particularly in those much hardened, or slightly exposed to air, spurious annulations are caused by the folding inwards or wrinkling of the skin (Plate XVI, fig. 2); but such crenations do not affect the muscular layers, and have no connection with the diverticula of the digestive chamber, or, as supposed by some of the older authors, with true annuli. A thin longitudinal section from the surface of the integument shows a series of meshes with crenated edges, the size of the spaces being variable. In *Nemertes Neesii* and *N. gracilis*, the cells or areolæ of the skin are smaller than in *A. lactifloreus;* the former having much dark pigment in its cutaneous textures dorsally; and the surface in *N. gracilis* sometimes presenting the appearance of microscopic mosaic work, from the beauty and fineness of its areolæ. In a young specimen, apparently of *Amphiporus spectabilis*,[1] transverse section demonstrates that while most of the longitudinal pigment-belts on the dorsum are in the cutaneous tissues outside the circular (external) muscular layer, two very well-marked stripes lie quite within both the latter and the longitudinal muscular coat. They are placed on each side of the arch of the proboscidian sheath, and doubtless are the cause of the darker appearance which characterizes the median bands when viewed from the dorsum. Similarly, in *Tetrastemma Robertianæ* the rows of pigment, constituting the two brown stripes on the dorsum, are at the inner border of the cutis—touching the circular muscular coat; while the median white stripe is placed within the longitudinal layer, exactly over the proboscidian canal. The reddish-brown pigment in the Zetlandic variety of *Tetrastemma candida* is also chiefly developed towards the inner margin of the cutis. Much brownish colouring matter is produced in the skin of the pale Amphiporidæ after prolonged confinement, and thus fresh examples from the rocks are always necessary for the more minute investigations. This is well marked in *Prosorhochmus*, where the pigment-cells and granules form a kind of meshwork by the looping of the rows.

The chief function of this elaborate glandular arrangement is, no doubt, the secretion of the abundant mucus, so characteristic of these animals, and which is often of a most tenacious description. I have seen a specimen of *A. lactifloreus* rapidly form an investment by this means, when placed in a vessel containing a little sand; and whether the sand-particles simply adhered to the gelatinous mucus by accident or otherwise, the animal took full advantage of the protection. The silky sheaths of *Tetrastemma dorsalis* are also examples of this cutaneous secretion. The same habit of tube-forming is extensively followed by the Amphiporidæ of our southern shores, apparently to protect themselves from the increased danger of desiccation. On placing a living specimen on a glass slip, and causing it to emit some mucus, the secretion proves to be a minutely granular fluid, intermingled with a few larger corpuscles; and it is produced by the entire surface of the skin, both in this group and in the Planariæ, not by any special portion thereof, as supposed by Mr. Darwin in the latter animals. One of the densest tubes is formed by *Nemertes carcinophila*, Kölliker, (Plate VI, fig. 5, and more highly magnified in fig. 6), and this has an

[1] This specimen was kindly sent, with other forms, by Mrs. Collings, of Sark.

areolar aspect, from the distribution of the granules or globules at intervals on the surface. Moreover, when viewed in profile, these globules are found to be elevated above the general surface, like a series of low pale warts. The tubes are attached to the hairs of the abdominal feet of female crabs (*Carcinus mænas*) bearing ova, and are evidently of intrinsic importance to the species, both as a protection against injury and desiccation. The very great change which ensues in the appearance of preparations deprived of the cuticular layer shows how important this is in giving character to the group. An interesting feature in regard to the skin of the Enopla (in common with the Anopla), is the reaction which ensues on testing with litmus-paper. An acid indication occurs in *Amphiporus lactifloreus*, *Tetrastemma melanocephala*, and *Nemertes gracilis*, amongst others, while a reaction not less distinctly alkaline is found in *Amphiporus pulcher* and *Nemertes Neesii*.

In regard to the chemical composition of the tubes secreted by these animals it may be remarked that Professor E. Grube submitted those of *Cerebratulus crassus* from Cherso to Dr. Lothar Meyer, who pronounced them to be formed of a substance closely allied to chitine. Tubes made by various British species are not much affected by strong acetic acid, and become pulpy only by prolonged action of *Liquor potassæ*.

The description of the tegumentary structures given by M. de Quatrefages differs materially from that just noted, a discrepancy arising partly from his confounding the structure of the Enopla with the Anopla, and partly from incorrect observations. His separation of the skin into two layers, the exterior composed of smaller, the interior of larger cells, is not evident in *Amphiporus*. Smaller cells sometimes do occur towards the ciliated surface, but the entire integument proper is continuous as a single layer. The only representative of his "fibrous" coat, which is described as lying within the former, is the structureless basement-layer. Max Schultze figures a small portion of the skin of his *Tetrastemma obscurum*, showing a series of large cells under the epidermis, with a few granular bodies interspersed, but the view is diagrammatic.

2. *Muscular Structure of the Body-wall.*

A very distinct belt of circular muscular fibres (Plate X, fig. 4, *c*), as in the Oligochæta, occurs under the basement-layer of the cutis. The fibres are compact throughout, and less bulky than the next coat, with which their filaments do not mix. The succeeding layer (*d*) forms a powerful investment of longitudinal muscular fibres, and, in transverse section, is generally somewhat crenated on the inner border, and fasciculated throughout. The interfascicular substance is transparent and structureless, and evidently as mobile and contractile as the fibres themselves. Numerous fibrous bands stretch from the inner surface in connection with the various contents of the body. In common with the Anopla, the muscular tissue is furnished with a delicate yet complete sarcolemma. Thus there are only two distinct muscular coats of non-striated fibres around the body of the Enopla, making an essential difference in this respect between them and the Anopla, to which (latter) previous observers have for the most part confined their investigations. It will be observed, moreover, that in the general order of their muscular layers the Enopla agree with the Oligochæta.

Anteriorly the body-wall terminates in a rounded snout of the usual cutaneous textures, presenting in transverse section (Plate X, fig. 1) an areolar and granular appearance, the soft contents of the areolæ having for the most part escaped. The aperture for the proboscis perforates the tissues just at the ventral border of the tip. A remarkable interlacement of fibres, occupying almost the entire cephalic region, occurs in front of the ganglia (Plate X, fig. 3). Powerful bands (1) pass below both the buccal cavity and the tube for the proboscis, meet, and cross each other in an oblique manner, making afterwards, by their divergence, extensive lateral connections; indeed, it will be observed that towards the inner muscular layer the fibres just mentioned form a broad fan-shaped arrangement. Some (2) pass upwards by the side of the central canal, and mingle with those descending from this region, while others (3) curve downwards to the ventral wall. Those (4) meeting above the central canal intersect each other obliquely in the middle line, so as to constitute a firm arch; and, besides, there are some transverse fibres (5) which cross over the canal and spread out laterally. Another series (6) slants downwards and inwards on each side of the cavity, and forms a firm junction inferiorly. The arrangement of these bands and fibres is so intricate, that each seems to blend with the other, and make a continuous anastomosis of contractile meshes. In addition to these oblique and radiating fibres, a powerful longitudinal series is interwoven with them in a complex manner, besides the denser grouping (*e*) at the margin (which indicates the inner muscular coat of the body), and the glandular masses in the centre. It will be observed that the bands which pass beneath the central canal are the most powerful, and offer a much greater resistance to the bulging of the proboscis and its sheath than the superior fibres, so that in extrusion the organ is mainly directed upwards (Plate X, fig. 8). The inferior commissure of the ganglia is thus somewhat protected by the arrangement of the fibres in front of it. The blood-vessel (Plate X, figs. 3 and 9, *l*) lies on each side in a sheltered angle between two series of fibres; and its calibre would not seem to be much interfered with except in extreme protrusion of the proboscis, though this is not of much consequence in the economy of these worms. All the oblique or transverse fibres are connected with the body-wall and the inner muscular layer, as are also the longitudinal at the tip of the snout. This elaborate interlacement provides in the best possible manner for the varied changes which the region undergoes during protrusion and retraction of the proboscis, and the ordinary motions of a tactile and mobile, yet not too yielding snout. The arrangement of the oblique and circular fibres around the longitudinal layer of the central canal must also act the part of a constrictor, and adapt the cavity to its ever-varying calibre. On the whole, the stroma in this group, from the greater predominance of cellular and granular elements, is less dense than in *Lineus*, and the interlacement of the fibres, though not more complex, is more beautiful, because possessing greater distinctness and regularity.

The posterior end of the body does not present this intricate arrangement, but the muscular fibres blend together and close in the cavity, with the exception of the small and sometimes indistinct opening of the great digestive chamber. The modes of fracture of these muscular coats in certain of the *Amphiporidæ* in a sick and perishing condition are interesting, the animal being separated into a number of beads, from the constriction and rupture of the body-wall at somewhat regular intervals.

In specimens of *Amphiporus pulcher* from which the cutaneous textures have been removed by improper preservation, the muscular coating has a glistening aspect, and is marked by a conspicuous double row of genital pores along each side. This glistening appearance of the muscular layer on removal of the cutaneous tissues is also seen in certain Planariæ.

M. de Quatrefages described the muscular coats both in Borlasia and Nemertes (especially instancing *Nemertes balmea*, our *N. gracilis*), as consisting of " external longitudinal and internal transverse" fibres. In the Enopla, as just mentioned, it is exactly the reverse, the circular fibres being external, and the longitudinal internal. He also represented another layer, within the internal, as forming an aponeurosis, apparently referring to the fibrous prolongations from the internal or longitudinal coat. Physiologically, it is certainly a better arrangement for an animal possessing only two muscular coats, to have the longitudinal fibres internal, for, on the occurrence of rupture, they, as well as the other tissues, are clasped by the circular; whereas, in the supposed arrangement of M. de Quatrefages, the longitudinal are beyond the reach of the constricting belt. Other organs also in the same animal, such as the proboscidian sheath and long posterior gland, have their circular fibres exterior to the longitudinal.

The actions of this muscular system are very varied, and include swimming or floating on the surface of the water, an action performed, as in the Nudibranchiate mollusks, by aid of the mucous exudation, and not, as stated by M. de Quatrefages, chiefly by the cilia.

3. *Proboscidian Sheath or Chamber.*

In the Enopla this chamber originates just in front of the ganglionic commissures, and continues without interruption nearly to the posterior end of the worm. It is recognised in the living animal under the lens, or even with the naked eye, as that forming a pale dorsal streak, and containing a transparent fluid. The commencement of the chamber is constituted by a fold (Plate XV, fig. 4, *a*) from the tube of the proboscis becoming attached to the parenchyma of the head, or, in other words, instead of a canal (*ab*) simply hollowed out in the cephalic tissues, free and distinct walls to the proboscis become apparent at this point. The reflection is the anterior boundary of the proboscidian chamber under ordinary circumstances, and it is against the obstruction so formed that the wave of proboscidian fluid first impinges in the evolution of the proboscis. The cavity gradually increases in diameter, and again diminishes towards the posterior end, where it terminates in a distinct *cul-de-sac*, a short distance in front of the tail. Its general appearance varies much (Plate XV, fig. 3, and Plate X, fig. 10), according to the position, degree of extension or contraction of the animal, sometimes almost clasping the elongated proboscis, at others having its attenuated walls stretched over the doubled organ.

The various transverse sections of the worms also render the relations of the cavity more apparent. Like the proboscis, its anterior end passes through the ring formed by the arch of the superior commissure, the inferior commissure and the sides of the ganglia. The nervous matter must thus occasionally be very much stretched, or else the proboscis is rarely launched out. This will be more particularly noticed in the description of the ganglia, and a reference to Plate X, fig. 8, will suffice for the present. The inferior commissure separates it entirely from the ciliated œsophagus (Plate XI, fig. 1). In structure the wall of the chamber is distinctly muscular, as evinced by its ever-varying condition. The fibres, however, are much less powerful at its commencement (Plate XI, fig. 1, *o*) than they afterwards become (Plate XI, fig. 2, *o*). Externally it is furnished with a layer of circular, and internally with a series of longitudinal muscular fibres, both again becoming thinner posteriorly. The comparatively large size of the chamber during life has probably caused several observers to err, by confounding it with the supposed general cavity of the body. This may readily be understood by examining a transverse section (*e.g.*, Plate X, fig. 10) of an animal which has been preserved with a distended chamber; then, indeed, it seems to be the chief cavity of the body. The presence of the reproductive elements also has a considerable influence in modifying the size of the space, which in the ripe animal is pressed upwards and towards the median line, while in the spawned worm it expands freely in all directions. It is a mistake, however, to suppose, with M. de Quatrefages, that no chamber exists posteriorly in the ripe animal, for it holds the same anatomical relations from the ganglia to the tail as at other seasons, only its calibre is encroached on posteriorly, and the consequent distention by the proboscis and fluid makes it more conspicuous in front. The chamber is not continued throughout the body in long species, such as *Nemertes Neesii* and *N. gracilis*, and is absent in the aberrant *N. carcinophila*.

In the foregoing cavity the proboscis floats in a clear fluid, apparently first noticed by Pallas, rich in large flattened corpuscles, which possess a minutely granular appearance. In the living animal these generally have a fusiform outline, from a slight enlargement in the middle (Plate X, fig. 15, *b*). They are also accompanied by certain globules and granules. The corpuscles vary in size, and frequently adhere together in a dying animal, from the very coagulable nature of the transparent fluid in which they float; and occasionally fibrinous shreds may be observed attached to them under the same circumstances. The fluid, indeed, is highly organized, and very different from sea-water, to which Dr. T. Williams compares it. When the proboscis has been gently protruded under chloroform, the corpuscles in the interspace may by-and-by be seen grouping together, so as to form stellate bodies resembling miniature Solasters, spiked bodies like thornapples, flattened structures with pectinate ends, and various other forms. In *Tetrastemma melanocephala* the corpuscles are comparatively small, some being clear, spindle-shaped bodies, others granular and rounded. The enormous increase of cells and granular masses in the proboscidian fluid, after the rejection of a proboscis, is well seen in this species. In other *Tetrastemmæ* the corpuscles (Plate X, fig. 14), though similar in shape to those of *A. lactifloreus*, are comparatively large; and in a variety of *T. flavida*, which I am inclined to regard as the *Polia sanguirubra* of M. de Quatrefages, they are tinged pinkish or reddish by transmitted light (Plate X, fig. 11). All are not similarly tinted, some being pale, others yellowish, while many are bright red, the colour in each case being in the nucleus. Globular bodies and granules are present, as in *Amphiporus*. The skin of this specimen contained many minute reddish pigment-specks, so that to the naked eye it had a delicate salmon-pink appearance. Reddish granular masses occasionally occur in the proboscidian chamber of *A. lactifloreus*, and in various species of *Tetrastemma*, generally associated with reddish specks in the skin,[1] and it is curious that a rejected proboscis assumes the same hue by transmitted light. After extrusion into the water, the shape of the corpuscles soon alters, and they adhere together and become translucent.

Amongst the authors who have alluded to the proboscidian chamber, Delle Chiaje and Grube seem to have possessed a fair knowledge of its arrangement and structure. Œrsted, again, gives a small figure of a transverse section of his *Notospermus flaccidus*, and characterizes the cavity as "canalis in quo penis est," indicating by a blank beneath what is evidently the digestive tract. He thus did not advance the physiology of the parts further than Huschke, who called the proboscis a male organ, and the nerves semen-canals. His interpretation of structures, however, is more distinct in his section explanatory of the Family Amphiporina, in which the digestive cavity

[1] In the reddish-brown Zetlandic variety of *T. candida* the proboscidian chamber contains many brownish-red pigment-masses.

is correctly alluded to. The reflection of the wall of the proboscis before-mentioned, in front of the ganglionic commissures, is the only barrier (and a very effectual one) that separates the proboscidian chamber from the tissues of the head. In no species has such a cephalic diaphragm as represented by M. de Quatrefages been found; but the ciliated œsophagus, to be described hereafter, takes its place, and leads one to infer that the distinguished naturalist has misinterpreted the structure. Besides, the head is not a hollow organ, requiring such definition from the other parts of the body. The same author, while explaining a transverse section of *Nemertes Borlasii*, shows a canal surrounding the proboscis; but in his description he confounds it with the general cavity of the body, and figures the proboscis occupying the centre of the latter posteriorly. This account, no doubt, refers to one of the Anopla, but he states that the same arrangement occurs in the Amphiporidæ, and represents in a *Polia* a series of transverse fibres as forming a platform (*plancher*) at the anterior and upper portion of the general cavity of the body, indicating its presence in his figures by a dark shading. No such arrangement of transverse fibres has been seen by me, but the characteristic ciliated œsophageal chamber occupies this situation. The somewhat erroneous views he entertained with respect to the relations of the corpuscular fluid of the proboscidian chamber may be understood by a glance at one of his figures, which depicts in *Polia sanguirubra* the proboscidian bodies floating in what he terms the genital cavity, and in which the genital cæca are supposed to lie. I cannot corroborate his statement that these corpuscles become much more numerous at the epoch of reproductive activity. The diminished size of the chamber may cause them to crowd anteriorly, but this is not an increase. Dr. Johnston likewise confounded the proper sheath for the proboscis with the general cavity of the body; and Dr. Williams, who styled the canal the œsophageal intestine, stated that it opened externally on the side of the body not far from the head, after the manner of the Sipunculidæ. M. van Beneden alludes to the sheath in *Polia obscura*, and compares the fluid and corpuscles to pale blood. Prof. Keferstein does not describe the chamber with sufficient clearness, and mentions that the proboscidian corpuscles are placed in the general cavity of the body.

The structure of the special corpuscles, and the highly organized condition of the transparent liquid in which they float, point them out as being, in all probability, concerned in nutrition, as first mentioned by M. de Quatrefages, though he likewise associated generation therewith. Some very interesting questions, however, are raised by their entire absence in *Nemertes carcinophila*, especially to those who, like the late Dr. Williams, think the fluid analogous to the peritoneal or perivisceral fluid in the true Annelids, a fluid, we may remark, which Professor Huxley considers the true blood, while he imagines the red fluid in the branching vessels analogous to the water-vascular system in the Annuloida. If in *Nemertes carcinophila* the proboscidian fluid had been more important in nutrition than that in the vessels, it certainly would not have given way to the latter. It is to be remembered, too, that this absence coincides with the atrophied condition of the proboscis itself and all its apparatus. It cannot be affirmed, also, of the Nemerteans, that the fluid in the so-called blood-vessels is devoid of corpuscles, for they occur in several species. Again, I think there can be no doubt the fluid and corpuscles exercise a very important influence on the reproduction of the proboscis, a process hereafter to be described, as well as promote the absorption of the débris of the discarded organ when it happens to be included in the chamber. But, while thus affirming that the fluid has a certain influence on, and bears a certain relation to, the development of the proboscis, it cannot be said to be indispensable to the presence of the latter, since there is a small proboscis in *Nemertes* *carcinophila,* where the fluid is altogether absent. In *Nemertes gracilis* and *N. Neesii* the proboscidian chamber gives way to the blood-vessels posteriorly, the latter, therefore, being the more important structures. The views of Dr. Thomas Williams in regard to the corpuscular liquid, which he termed the "chylaqueous fluid," are so much at variance with accuracy, that I cannot pass them over in silence. He remarks that "in the case of the Borlasiadæ, Planariadæ, and Liniadæ, the chylaqueous fluid is contained in the digestive cæca and diverticula. In some of the Planariadæ, however, I have proved that a space does actually exist between the digestive diverticula and the solid structure of the body, *which is lined by a vibratile epithelium,* and into which probably the external water is in some way admitted. By this water, thus situated, the contents of the digestive cæca are aërated. The fluid oscillating in these cæcal appendages of the stomach is thickly charged with corpuscles, which, from their regular character, prove this fluid to have already reached a high standard of organization. They occur as elliptical cells in the *Borlasia* from which the illustration (fig. 25) was taken; the fluid abounded also in small orbicular points, constituting the 'molecular basis' of the digestive product. In this worm it is this fluid, and not the true blood, that is aërated; the latter system is too little developed."[1] This quotation clearly shows that he was quite unaware the so-called "elliptical cells" are always confined within the proboscidian sheath; as well as points out the erroneous notion he entertained of the true digestive tract, which in all cases can readily admit salt water (by mouth or anus), if such be required, but certainly not for the purpose of converting it into "a *vital* organized fluid." The proboscidian liquid and corpuscles, as I have previously shown, are very far removed from sea-water, and hence have little analogy with the "chylaqueous fluid" so frequently mentioned by investigators of the Invertebrates.

4. *The Aperture for the Extrusion of the Proboscis.*

This orifice is situated towards the ventral edge of the tip of the snout, and under favourable circumstances in the living animal, may be seen as a terminal pore, surrounded by a closely set series of radiating lines; as, for instance, when the snout is bent upwards towards the tube of the microscope (Plate X, fig. 16). The aperture has been called a genital pore by not a few authors, *e. g.* Œrsted, Leuckart, and Quoy and Gaimard; while others, such as Johnston, De Quatrefages, Busch, Williams, and Girard, have interpreted it to be the mouth; indeed, since the proboscis was by many considered the alimentary organ, it could not be otherwise. It is furnished with longer cilia from an early period; and in the adult these (cilia) form, when the lips are slightly pouting, a very pretty arrangement (Plate XV, fig. 4, *a c*), similar to the analogous opening in *Lineus* (Plate XIX, fig. 1). The striated ring surrounding this passage in transverse sections of the tip of the snout (Plate X, fig. 1) indicates the special muscular coat pertaining thereto. The canal (Plate XV, fig. 4, *a b*) proceeds straight backwards from the aperture to a point in front of the commissures of the ganglia, where it meets the differentiated walls of the proboscis (at *a*); and the cilia can be traced to this region, but no further. The tube is simply hollowed out in the tissues of the head, and is quite independent of the motions of the proboscis. It has a series of longitudinal muscular

[1] 'Philos. Trans.,' part ii, 1852, p. 627, pl. xxxii, f. 25.

fibres beneath the ciliated mucous surface, and the strong oblique and circular bands (Plate X, fig. 1) form a very efficient investment. When the proboscis is about to be ejected, it commences to fold over, like the turning of a finger of a glove inside out, at the point (Plate XV, fig. 4, *a*) in front of the ganglionic commissures, a fact which has escaped most observers. In withdrawal also, it may be noticed that, towards the conclusion of the process, the last wrinkle of the proboscis glides within the terminal aperture, and slowly passes backwards till this point is reached, when it ceases, and the organ is once more in its ordinary condition, any change that afterwards ensues being due to the stretching of the shortened tube—a process of simple elongation. Thus the anterior portion structurally and functionally differs from the succeeding, the wall of the proboscis always intervening between it and the proboscidian fluid.

The attenuated coats of the proboscis curve outwards all round, and become fixed to the wall of the foregoing canal and other cephalic tissues just in front of the ganglia; the reflection constituting the *point d'appui* against which the wave of proboscidian fluid impinges, when the organ is about to be extruded. The thin anterior wall of the proboscis unrolls, the terminal pouch is distended by fluid, and then the organ is rapidly launched forth. To judge from the descriptions and drawings of M. de Quatrefages, the entire force of this liquid would be thrown against the posterior part of the nerve-ganglia, and the straitened border of his hypothetical "diaphragm" would not pass further forward. In my specimens, the waves of the proboscidian fluid debouch readily into the yielding anterior canal in front of the commissures, and then externally into the loop of the extruded proboscis. I have never seen the very pretty lozenge-shaped arrangement of muscular bands in the snout, as figured by M. de Quatrefages, and whose function, he states, is to dilate the "oral" orifice, and carry the "gullet" forward; but the elaborate stroma, shown in Plate X, fig. 3, would amply suffice for this. During the motions of the proboscis, the reflection in front of the ganglia assumes various postures, and it frequently does stretch obliquely forward and outward from the tube, especially when that is drawn backwards. On the other hand, when the tube is thrust forward, the fibres slope forward and inward.

5. PROBOSCIS.

I shall divide, for convenience in description, the proboscis of the Enopla into three regions, viz., the anterior, middle, and posterior. The first (Plate XV, fig. 3, A) comprehends the somewhat cylindrical portion between the reflection in front of the ganglionic commissures and the commencement of the stylet-region; the second (B) includes the stylet-region and the well-marked swelling of the great muscular reservoir; and the third (C) is represented by the long posterior chamber.

A. *Anterior Region of the Proboscis.*

From the point of reflection backwards, the proboscis gradually increases in diameter until its full size is attained (Plate XIV, fig. 1, and Plate XV, fig. 3), and then it remains nearly cylindrical as far as the stylet-region. The entire organ is proportionally larger than in *Lineus*, and its anatomy more apparent; though I very much doubt, even in this group, if we can assign it the ideal office of a vertebral column. At the point of reflection there is sometimes a kind of *os* (Plate XV, fig. 4, *a*), from the slight folding of the lips of the organ in the early stage of ejection. The muscular fibres are chiefly longitudinal at the commencement, and if in a partially protruded proboscis a section be made in front of the ganglia (Plate X, fig. 9), the difference between this and the succeeding reticulated portion is very conspicuous. Occasionally the organ assumes a twisted position under examination, so as to give the fibres a spiral appearance (Plate XVI, fig. 1, *a*), and in such a state the structure might fancifully be likened to the spiral arrangement of the muscular fibres in the œsophagus of certain of the higher animals; but this condition of the proboscis is purely accidental. I fear, however, it has led M. de Quatrefages into an erroneous interpretation of the anatomy of the organ in *Polia glauca*, the proboscis of which is described and figured as having regular spiral belts at its commencement. The same author again avers that in *Polia mutabilis* the latter portion consists of two longitudinal muscular coats separated from each other by a cellular layer, a provision, he explains, for enabling each to act independently. He also adds that no circular fibres were seen in this species, in *P. filum* and some others. Dr. Johnston, on the other hand, considered the organ to be homogeneous.

In very small specimens of the British examples the transparency of the tissues of the proboscis renders definition of the coats somewhat obscure, especially after mounting in chloride of calcium; but, so far as I have observed, the structure is as follows:—Externally is a layer of elastic tissue (Plate XI, figs. 4, and 9, *g*), which is more distinctly striated in transverse than in longitudinal sections. Towards its free border, also, certain obscure granular markings observed in the latter sections (Plate XI, figs. 7 and 8, *g*) show that the course of the external fibres is different from the others; indeed, in some views, the appearance is such as to raise the suspicion of the presence of the ends of a few fine muscular fibres, the rest being nearly homogeneous. The next layer is a somewhat narrow belt of longitudinal muscular fibres (*f*), which may be termed the *external longitudinal muscular coat*. It consists of pale, unstriped, muscular fibres. Between this and the other longitudinal layer is a remarkable stratum, the *reticulated coat* (*e*), which in transverse sections (Plate XI, fig. 4) assumes a regularly moniliform appearance, from an increase of its constituent substance at certain points. In many longitudinal sections (*e.g.* Plate XI, fig. 8) the ends of numerous fibres are found in this layer, as if it was composed of circular fibres; but the appearance is due to intermediate bands which pass between the thicker longitudinal columns. If a thin longitudinal slice from the organ in *Amphiporus pulcher* is hardened and mounted in chloride of calcium, numerous well-marked homogeneous longitudinal belts are seen at regular intervals, and between them are many connecting transverse fibres. The ends of the fibres in these sections have therefore been caused by the knife severing the latter series. Thus the tube is surrounded by a complete investment of this elastic meshwork, which, doubtless, has an important physiological bearing on the varied movements of the organ. In the *Amphiporus grœnlandicus* of Œrsted, the longitudinal belts of this layer are somewhat rounded in transverse section. The succeeding stratum (*d*) consists of a powerful series of longitudinal fibres, fully twice as thick as the external longitudinal layer, and which may be termed the *inner longitudinal muscular coat*. In essential structure it resembles the exterior, differing only in bulk. In sections prepared by hardening in alcohol, these fibres, in common with others in the organ, present a coarser appearance in transverse section than after hardening in chromic acid. The fifth layer from without inwards is a strong band of circular fibres (*e*), the *circular muscular coat*, which forms a counterpoise to the preceding. Within is a *basement-layer* (*h*) of pale translucent texture, best seen in longitudinal sections (Plate XI, fig. 8), for in transverse cuts the coat is apt to be confounded with the inner layer of circular fibres. It has, on the whole, a homogeneous appearance. Upon this layer rest the peculiar glandular papillæ, which arise from a distinct margin on its inner edge (Plate XI, figs. 8 and 9, *b*). In the ordinary transverse sections of the proboscis these organs form *en masse* a somewhat foliated or frilled arrangement, often of a very symmetrical appearance. In contracted specimens the entire cavity is filled up by them and their translucent gelatinous mucus. The largest villi or glandular processes (Plate XI, fig. 10) are situated some distance in front of the stylets, for towards this region they become smaller, and finally the fundus is clothed only by minute papillæ. Sometimes they present a coarsely fringed appearance, with large granules in their interior; and when the tube has been turned inside out they have a villose aspect, the tough mucus adverted to above projecting in filaments from their surface under the slightest pressure. I have generally observed, also, towards the first portion of the protruded organ, fine motionless processes like cilia jutting from the apices of the glands, and they are probably homologous with the minute spikes which occur on those of the posterior region after rupture from pressure. I do not think, at all events, that they can be called urticating organs. In *Tetrastemma* the glandular papillæ are leaf-shaped, and somewhat crenated at the border, where there is a regular moniliform appearance from the arrangement of the globules (Plate X, figs. 19 and 20). Under pressure, they are granular internally, and furnished with numerous globular or wedge-shaped mucous masses that refract the light like oil. The same type of structure is found in the proboscides of Amphiporidæ from New Zealand, only the longitudinal bands of the reticulated layer are more numerous than in *A. lactifloreus*.

The description just given of the structure of this region differs much from that of M. de Quatrefages, almost the only author who has entered into the minute anatomy of the proboscis in the Enopla. He states, like Mr. H. Goodsir, that externally the tube is supplied with a series of transverse muscular bridles, which maintain it in position within the body of the worm, and he shows a section of the parts in *Nemertes balmea,* which bears out his description very well; but he did not observe that, if such bridles existed, they would have to pass through the muscular sheath in which the organ glides, before reaching the body-wall of the animal. His minute anatomy of the proboscis is chiefly taken from the examination of *Borlasia angliæ*, and hence cannot apply in any degree to the Enopla, though he considered it the type of both. He makes only two muscular layers in the wall of this organ, and though in his section from *B. angliæ* he indicates "traces de fibres transversales," by a few lines crossing these longitudinal coats, he distinctly observes that they are not apparent in the smaller species. The longitudinal fibres are separated, he states, by a transparent homogeneous tissue, which forms a great number of bridles of very elastic fleshy columns, making, in other words, an elastic cellular layer; and he figures this in the before-mentioned section, adding that this lax cellular arrangement will give the two longitudinal muscular coats that independence of action necessary for the proper performance of their functions. It can only be supposed that he refers to the *reticulated layer* by this description. He mentions a transparent homogeneous coat within his longitudinal muscular layer, corresponding to the mucous coat of the higher animals, and adds that the papillæ of the latter are all covered with vibratile cilia. M. de Quatrefages thus describes only four coats, viz., mucous, internal longitudinal, elastic cellular, and external longitudinal; and if the stays or bridles which he notes as connecting the tube to the body-wall be taken into account, it may be surmised that the muscular sheath for the proboscis is included in his reckoning. No cilia occur in this organ.

B. *Middle Region of Proboscis.*

The elongated chamber just described terminates posteriorly in a sort of *cul-de-sac*, into which three small apertures converge; one at each side from the marginal stylet-sac, and a central (at *a*, Plate XII, fig. 1), in the pit of the cavity, connected with the reservoir. The walls of the proboscis undergo a considerable change in this division, especially with regard to the deeper layers. Externally the investing coat from the anterior region is continued on the commencement of the reservoir (Plate XIII, fig. 10), and has a crenated border in the contracted state of the parts, with transverse markings or rugæ; but this appearance does not of necessity indicate the presence of circular fibres, for the contraction of the longitudinal layer underneath would cause even a very feebly elastic coat to assume similar markings. The thin subjacent layer of longitudinal fibres is likewise continued to a similar extent on the reservoir, and assists in connecting the divisions. These two layers lie exterior to the stylet-sacs.

The structure of the pit or termination of the anterior chamber (*η*, Plate XII, fig. 2) requires special notice. The large glandular papillæ of the inner wall gradually diminish in size, as before-mentioned, until the floor is covered only by small, densely arranged and minutely granular processes, giving the surface, which in the ordinary state of the parts bends backwards all round the stylet in the manner shown in the figure, a smoother appearance. The fibres also become firmly bound together, so as to constitute a sphincter for the aperture, and gently curving outwards and backwards, are lost in the obscurity of the parts caused by the external circlet of glands, somewhat behind the anterior termination of the wedge-shaped investment of the apparatus at the base of the stylet. This floor of the chamber is composed of a series of muscular fibres, whose direction, in the ordinary state of the parts as a transparent living object, is outwards and backwards, but which assume various aspects during the motions of the organ. Thus the floor passes from the conical form with the apex directed backwards to that of a transverse platform; and in the everted condition has the shape of a cone the apex of which is directed forward (Plate XIII, fig. 14). In the latter position the secure binding of the fibres which surround the central aperture just permits the stylet to project, and no more. The whole arrangement constitutes a large muscular pit with very powerful and mobile walls, capable of many and varied alterations of form. In firm contraction of the region the floor of the chamber is pouted forward (Plate XIII, fig. 7), causing a radiated appearance of the fibres, which thus slant outwards and backwards from the central point. A firm constriction of the tube often takes place at the anterior border of the stylet-region, separating the pit of the organ from the more villose or glandular portion in front, and making a double swelling of the parts. Immediately before the marginal stylet-sacs lie some coarsely granular glands, which, however, are less conspicuous than in *N. gracilis* and others. Prof. Keferstein speaks of this region as having only a longitudinal muscular coat (though the crenated border of the anterior chamber is continued thereon in his figure), and as possessing much pigmentary and granular matter. The latter is not well-marked in *A. lactifloreus* or *Tetrastemma*, since the entire apparatus is either translucent or white; but in certain species, as will hereafter be shown, an increase in the granular substance occurs. The longitudinal fibres of the last-mentioned author end at the posterior border of the stylet-region.

This division is of the same glassy translucency as the reservoir, while both the anterior region and the long posterior are of an opaque-white in the fresh specimen. Externally it has the investing layer (Plate XII, figs. 1 and 2, *g*) carried from the anterior chamber, and which passes back to the next region. Beneath is a series of very powerful and conspicuous longitudinal muscular fibres (*f*), apparently to some extent continuous with the most developed longitudinal layer of the preceding region, but few of which pass on to the next. Internally the oblique fibres stretching backwards from the floor of the anterior chamber form the band η (Plate XII, figs. 1 and 2). The rest mingle with the radiating fibres from the central investment. In transverse sections of the anterior part of the region, in the line of the marginal stylet-sacs (Plate XVI, fig. 4), the centre is occupied by the basal granular apparatus, which is generally thrust forward in spirit-preparations, surrounded by its special investments and a belt of circular fibres. The greater part of the region without is occupied by a dense series of radiating fibres, which form the spokes of the wheel, while the ends of numerous longitudinal fibres fill up the spaces between them. If the section is close behind the floor of the anterior chamber, some of the circular fibres which close in the cavity, and other parts of the proper wall of that division are included, while if the cut is a little further back, the granular glands come in the plane of section. The exterior of the region in all cases is occupied by the elastic and longitudinal layers. The alternation of radiating or oblique with longitudinal or nearly longitudinal fibres continues to the posterior end of the investments of the basal apparatus, the only change towards the posterior part being the introduction of the ejaculatory duct, and a few circular fibres to its exterior. The pale region behind the basal apparatus has a very complex structure, consisting of densely interwoven fibres that surround the wall of the ejaculatory duct, those towards the circumference showing an arrangement similar to the anterior portion of the region, viz., having the (cut) ends of fibres in the axils of the radiating series. In longitudinal sections of the organ these interlaced fibres are chiefly transverse in direction; and in some preparations there are numerous granules at the sides, within the somewhat well-defined border formed by the fibres curving backwards (at η, Plate XII, fig. 2), and which corresponds to the lateral arches of the cavity in *A. pulcher*. The stylet-region proper is distinctly separated at its posterior border from the reservoir by a pale boundary-line under pressure, so that the parts have a somewhat jointed appearance.

a. The Marginal Stylet-Sacs.

These organs (ν, Plate XII, fig. 2) occupy the exterior (covered only by the elastic coat and the external longitudinal fibres) of the somewhat solid wall of the section immediately succeeding the anterior region, and often cause a distinct swelling under examination. They are conspicuous by their aqueous translucency, as well as by the nail-shaped stylets in their interior, though the exact position of their long axes is rather difficult to determine. In ordinary views, when the animal is examined as a transparent object under pressure, their long diameter is antero-posterior, or slightly oblique; but in the prepared specimen this is often transverse (Plate XI, fig. 5). Each sac is ovoid in outline, has a thin, transparent, contractile investment (sufficiently tough to prevent the points of the stylets piercing it during the motions of the worm), which lies directly under the superficial layers of the division, and a duct passing from its central region to communicate with the pit of the anterior chamber of the proboscis. The direction of the duct in the position above mentioned (*i. e.*, viewed as a transparent object) is forward and inward, but, like other structures pertaining to this variable organ, it is liable to many alterations, and is occasionally much stretched and attenuated. It is also slightly narrowed on approaching the sac (Plate XIII, fig. 11, *a*), and has at its junction therewith a series of protecting fibres. De Quatrefages and Max Schultze do not notice the duct at all, and Claparède's figure shows it distorted from pressure in *Tetrastemma*, but Keferstein's representation is more accurate. Each sac contains a variable number of the characteristic nail-shaped stylets (β), from three to five—more or less—in different stages of development, as well as certain clear fluid vesicles (ϵ), globules and granules, and is quite filled by a transparent liquid. The stylets very much resemble a lath-nail of cast-iron, and are formed of a translucent calcareous secretion; indeed they appear like spikes of the purest crystal. The head is bulged, rounded at the edges, and somewhat flattened at the top, an elongated conical spike with a sharp point proceeding therefrom. The perfect spike or spikes in these sacs are usually about the size of the central stylet, and there are often three or four that can scarcely be distinguished from each other. Besides the perfect organs, there are some with heads not fully developed, but complete in other respects; the remainder again present the form of simple spikes of various lengths devoid of any head. In a few instances the centre or axis both of the head and point of the stylet is granular, while the superficial portion is of the usual homogeneous aspect. They seem to be formed by gradual increase of layer upon layer of the calcareous glassy secretion, as is well shown in some specimens mounted in chloride of calcium, which have assumed a stratified, or laminated appearance. Sometimes a process (Plate X, fig. 18), probably the remains of a globule, passes from the head a short distance over the base of the spike, as indicated by Max Schultze in *Tetrastemma*, though seldom to such an extent in the complete stylet. The knob on the head of the stylet figured by this author must be rare, and probably represents a casual globule. The stylets are dissolved in weak acetic acid, as first noted by M. de Quatrefages, and are roughened or corroded by a strong solution of caustic potash.

In a large animal (*A. lactifloreus*) an interesting arrangement of the stylet-sacs occurred on one side, for there were two of nearly equal size (Plate XII, fig. 1), connected with each other at one end, so that an interchange of fluid and granular contents took place. Only one had a duct of communication with the anterior chamber of the proboscis. The opposite side was furnished with a single sac of the usual formation, containing two large and perfect stylets, and a shorter without a head. On the abnormal side the outer sac (in this view) had two well-formed stylets, a larger and a smaller clear globule, besides some other minute globules and granules; the inner, which possessed the duct of communication, had one stylet as large as the preceding, and fully formed; another somewhat less, but also having a head; a third slender spike of greater length than the latter, but headless; and a fourth, rather more than half the length of the last-mentioned. No globule existed in the inner sac. It is interesting to notice the different degrees of perfection of these spikes in relation to what Dr. Max Schultze avers as to their development, viz., that they are the products of the smaller contained vesicles. In the one there were two large globules, and two perfect stylets, yet no trace of a developing spike; in the other there were three completely formed stylets, yet each varied in length; while the long spike without a head was fully as long as the largest in that sac—head included. Those in the outer cavity were quite as large as the central stylet. In *Tetrastemma candida* I have observed, besides the ordinary stylets, a group of minute crystalline spines, which had no connection with the clear vesicle of the sac. Thus, at present, though I have very often seen these organs inside, and connected with the fluid vesicles, I cannot altogether support Max Schultze's notion that they must be developed therein; and this would not signify much, since the entire cavity must act as a secreting chamber, else the large ones could receive no increase after they had outgrown the capacities of the globules. M. Claparède stated, in his 'Recherches,' that he had never seen spikes inside those vesicles, but in his subsequent 'Beobachtungen' he figured a developing stylet in a globule in *Prosorhochmus Claparedii.*

In a specimen that had often been under the microscope, I found on one occasion a pair of stylets, apparently from the marginal sac of one side (though this is by no means certain), advanced nearly to the ganglionic portion of the proboscis. One marginal pouch was at any rate empty, while the other retained its three stylets. The free stylets moved very slowly forward, scarcely any progress being made during an hour's observation. At this time the empty sac contained numerous granules, but no circular or ovoid vesicle. Twenty-four hours after the stylets had disappeared. The sac is now observed to be much less than its fellow of the opposite side, and somewhat shrivelled and undefined; but it contains a small ovoid vesicle, which is traversed by a minute slender spike, whose long diameter exceeds that of the globule, and therefore it cannot be supposed to be within it. In addition there is a free spike, about a third the length of the former. The larger has assumed the shape of a stylet without a head; the latter is as yet nearly cylindrical (Plate XII, fig. 3). Whatever the function of these organs in the marginal sacs may be, there can be no doubt they have nothing to do with the supply of the central apparatus, for that furnishes its own stylet.

b. Ejaculatory Duct.

Through the same region the ejaculatory duct (μ) passes to the point where it opens into the muscular space behind the constrictor of the central aperture in the floor of the anterior chamber. The opening (μ') of the duct is generally obscured by the apparatus of the central stylet, unless the observer sees it at the moment of contraction of the powerful muscular walls of the reservoir, when the mucous or villous lining is driven forward so as to render the channel more apparent, and a vigorous jet of the minutely granular fluid is propelled into the muscular sac, and then through the stylet-aperture into the floor of the anterior chamber. Closer observation, even when such convulsive contractions are absent, occasionally shows the molecular fluid passing onwards to the anterior chamber; and if the ejaculatory duct is not obscured by the glands, the moving granules of this peculiar fluid are seen therein. Moreover, when the large compound cells (Plate X, fig. 17) have been detached under pressure, and squeezed forward into the reservoir and along the duct, the calibre of the opening into the muscular sac may be ascertained with tolerable accuracy, and is so small that only a single cell at a time can be transmitted. The duct has a bent-conical form, a shape that avoids interference with the basal apparatus of the stylet, which occupies the centre of the region; and its posterior end (that opening into the reservoir) is capable of a certain amount of constriction, as indicated in one of M. Claparède's figures. In the latter state the inner or convex side of the duct is glandular, while the outer or concave is not. A layer of longitudinal fibres, continued forward from the reservoir, constitutes the proper wall of the tube, and it is this coat which causes the distinct ring round the duct in transverse section. Internally it has a mucous lining, which generally possesses a few small glandular papillæ towards its posterior end. The duct is not very dilatable, the cavity becoming elongated, but not much increased in diameter, even under violent expansive force. It can be firmly closed by the contraction of the region surrounding it (Plate XII, fig. 9, and Plate XIII, fig. 7 μ) so as to be indicated by a mere central streak. The whole structure of the channel, and its relations to surrounding parts, show that it is formed, not for transmitting fluids from before backwards, but entirely in the opposite direction. The mobile muscular space (ϵ), into which this duct opens, forms a kind of sac that is occasionally distended with the cells and granules, before they reach, through the central pore, the pit of the anterior chamber.

c. The Central Stylet and its Apparatus.

The central stylet projects straight forward into the floor of the anterior chamber in the usual state of the parts, and is generally about the same size as the largest stylet in the marginal pouches, with which (stylet) it likewise agrees in structure and composition (Plate XII, figs. 1 and 2). Its base is fixed to the granular apparatus (λ); the arrangement being not inaptly likened by Dr. Johnston to an awl, the anterior or smaller end of the structure sending its investing substance over the head of the organ, and grasping part of the spike. The basal apparatus (or awl-handle) is narrowed anteriorly, gradually widens backwards, is then marked by a constriction, and again terminated by a dilated portion, which may represent the butt of the awl. This structure is shorter in proportion to the stylet, and has its constriction placed further backwards than in *Tetrastemma candida*. It is opaque-white, and coarsely granular from an early age, the granules disappearing with effervescence under the action of weak acetic acid, and rendered pale, in some cases dissolved by caustic potash. These granules would not seem to be simply enclosed in the structure, as if in an ordinary sac, but they adhere together and form a consistent whole, as proved, amongst other things, by their not falling out of the fragment in transverse section, or when the anterior part is cast off with the stylet, as will hereafter be described. I have also seen the stylet and its granular apparatus thrown off together in a discarded organ in the proboscidian chamber of *T. melanocephala* and other species. This peculiar granular structure or sac (θ) is set in a firm wedge of translucent, and, under ordinary or external appearances, structureless substance; but the addition of caustic potash or acetic acid shows distinct striæ, chiefly of a transverse character when viewed under pressure, and therefore of a radiating nature in relation to the apparatus, as clearly proved by a transverse section. An interesting condition was found in two specimens of *Tetrastemma flavida*, which directly bears on the physiology of this part. In each a fragment of the granular apparatus, with the central stylet attached, lay towards the anterior end of the first region of the proboscis; and since injury would scarcely have caused a result so systematic, it is evident the stylet had been thrown off by the animal. In both cases the apparatus of the central stylet was complete, only in one its anterior part appeared pale, and there was a slight irregularity in its outline, similar to that in Plate XI, fig. 13. In each, the marginal sacs had the full complement of stylets, one or two of which equalled the central in size. There appears to be only one explanation of this condition, viz., that the central stylet can be thrown off, and somewhat rapidly regenerated; for it is unlikely that in each case it found its way there from without. Former experience in regard to the stylets shows that such bodies take some time to gain the exterior of the worm, and hence our surprise is lessened at the perfection of the new structures while the old have not yet escaped from the proboscis. Besides, the anatomy of the parts in *A. pulcher* will by-and-by throw still further light on the subject.

In front of the wedge-shaped translucent mass surrounding the basal apparatus of the central stylet is the muscular space (ϵ, Plate XII, fig. 1) previously mentioned, into which the ejaculatory duct opens (at μ'). This cavity is formed by the folding outwards of the floor of the anterior chamber all round, and it is furnished with a special inner muscular coat. The walls are thus very mobile, and occasionally form an hour-glass contraction in the middle, quite distinct from the narrowing between the sac (whose greatest diameter is in front) and the firm wedge behind. Its anterior border can be carried to the tip of the central stylet; while in the extruded state of the parts (Plate XIII, fig. 14, ϵ) it forms, when seen from above, a compressed process at each side of the basal apparatus of the central stylet; more correctly, however, and if viewed from the front, it has the shape of a muscular umbrella, which slopes all round the anterior portion of the latter. M. Claparède does not mention this arrangement at all, and M. de Quatrefages seems to have mistaken it for a pair of glands, which, he explains, probably secrete poison for cankering the wounds inflicted by the stylet, a supposition unsupported by any anatomical basis as regards this spot. Professor Keferstein's structure of the region also requires amendment, since he does not distinguish the separation between the cavity and the floor of the anterior chamber; thus, in his drawing of the extruded proboscis, the central stylet projects smoothly into the water, and the ejaculatory duct opens directly into the latter a short distance from the stylet.

d. Granular Glands of the Stylet-Region.

The glands (π) have the form of lobules, with the long axis of each parallel to that of the proboscis, and are situated beneath the two external layers of the part. The position of the stylet-sacs is always external to these organs. The constituent granules are proportionally large in *Tetrastemma*, and especially so in *Prosorhochmus*. I have not found any structural guide to their function, though they are invariably present in the Enopla.

e. The Reservoir.

The cavity or reservoir (ρ, Plate XII, fig. 1) from which the ejaculatory duct proceeds is a somewhat globular or ovoid chamber, with its long diameter for the most part directed transversely; or it may be compared to the bowl of a short and wide wine-glass, the stem being formed by the peculiar channel of communication with the long posterior region. It is liable to much variation in shape, from the contractility of its inner wall, independently of the action of the massive exterior muscular investment. Extreme contraction of the region transforms the globular cavity into a mere transverse slit. Its inner surface is provided with a series of glands, the larger and more distinct (σ) having minutely granular contents, and easily distinguished from those of the anterior chamber or long posterior region. Towards the opening of the ejaculatory duct the glands are smaller than in the dilated part of the reservoir, and they again decrease in size before the organ narrows to form its posterior channel of communication. In this comparatively large chamber the granules, hereafter to be described, have free scope for the display of their movements, and not only do they move themselves, but they cause bodies so large as the compound gland-cells from the posterior chamber, when they happen to be present, to revolve and jerk also, a state of matters that has probably helped to mislead M. de Quatrefages as to the ciliation of the organ. Such, however, is very distinct from ciliary motion. The reservoir diminishes posteriorly, so as to form in the contracted state of the parts a very narrow duct (ϕ), which by-and-by expands, and becomes continuous with the posterior chamber, the whole forming an hour-glass arrangement, as represented in the various figures.

The minute structure of the reservoir possesses considerable interest, both as regards beauty and complexity. On reaching the point *a* (Plate XIII, fig. 10), the elastic and the external longitudinal muscular coats of the proboscis for the most part cease. Before this occurs, however, the muscular fibres (τ, Plate XII, fig. 2) peculiar to the region arise, sweep backwards in a beautiful fan-like manner over the reservoir, curve round and meet those from the opposite side, and leave only a small space in the centre posteriorly, through which the channel of communication with the third region passes. When viewed as a transparent object under pressure, or in longitudinal section, the direction of these fibres is backwards and inwards. This great muscular mass does not receive accessions from the outer wall, but the whole of the loops come from the front. By the varied crossings of these fibres a felt-like aspect is produced (Plate XIII, fig. 01). In addition, there are circular and longitudinal fibres within the latter, to the presence of which the independent wrinkles of the cavity are due. The longitudinal layer (τo) is innermost, and forms a kind of spindle-shaped arrangement; the anterior fibres—commencing with the ejaculatory duct (of which they form the special wall)—soon expand to cover the dilated cavity of the reservoir, then are narrowed as they surround the channel of communication, and proceeding backwards, merge into the longitudinal coat of the posterior chamber. In some positions these fibres assume an obliquely crossed or spiral aspect in the channel; but, as in the case of the ganglionic region of the proboscis, this is purely accidental. The margins of the reservoir and the channel of communication are marked under pressure by the ends of muscular fasciculi, especially posteriorly; an appearance due to the doubling of the looped fibres, but also partly to the presence of the thin circular coat which lies without the longitudinal. The peculiar curvature of the fibres of the reservoir causes a transverse section of its posterior part (Plate XIII, fig. 15) to assume a radiated spiral appearance, the whole reminding one forcibly of Dr. Pettigrew's beautiful diagrams of the arrangement of the muscular fibres of the heart; and in this case no better structure could have been devised for the complete and forcible evacuation of the chamber. By the contraction of the various fibres, the cavity is squeezed with great force in every direction, like a thick caoutchouc ball or globular syringe in the hand. Its transverse diameter is lessened, and, still more, its antero-posterior, while a jet of the minutely granular fluid is squirted into the anterior chamber; and, in spasmodic efforts, even a prolapsus of its glandular lining occurs. In contraction (Plate XII, fig. 9) the entire region is much shortened, and the mass of the looped muscle increased posteriorly. Not only does the peculiar spiral curvature of the fibres cause the most powerful compression of the cavity, but the posterior aperture has a tendency to be closed and slightly carried forward, the anterior being less subject to interference. The closing of the posterior aperture (channel of communication) is also greatly assisted by the circular fibres lying outside the longitudinal.

In extrusion of the proboscis (Plate XIII, fig. 14), the entire spike of the central stylet projects, the floor of the anterior chamber forms all round a thick and powerful umbrella-shaped cushion (whose independent structure escaped Professor Keferstein), the marginal stylet-sacs are under cover, and the region of the reservoir is shortened and widened. The position of the muscular chamber (ϵ), which forms a second small umbrella round the apex of the basal apparatus of the central stylet, is characteristic.[1] The separation between the longitudinal fibres of the stylet-region proper and the looped fibres (τ) of the reservoir is distinctly indicated. It will also be observed that the whole stylet-region is dilated by the forcible wedging forward of the reservoir.

c. *Posterior Region of the Proboscis.*

Behind the translucent region just described, the opaque-white long posterior chamber (c, Plate XV, fig. 3) occurs. It communicates with the reservoir in front, but its posterior end is cæcal. The contractile nature of the parts renders comparison uncertain, but it is generally not much shorter than the anterior chamber in the perfect animal; sometimes, indeed, it exceeds the latter part in length, the simple structure of its wall giving it greater extensibility. In young specimens and in regenerating organs, again, it assumes a nearly globular form in contraction. Externally it is covered by a very delicate investing layer. Within is a series of circular muscular fibres, which towards the tapering posterior end become indistinct, and finally disappear altogether after the cæcal tip is reached (Plate XI, fig. 16). The next coat is formed of an equally strong series of longitudinal fibres, the anterior or primary bundles being continuous with the longitudinal layer of the reservoir, as previously mentioned. These run throughout the entire length of the chamber, becoming proportionally more developed as the central cavity diminishes posteriorly, and finally merging into the terminal muscular ribands. The mucous layer with its glands lies within the latter coat (Plate XIII, fig. 16), though in several views, both in the living animal and in transverse sections, I fancied some sub-mucous circular fibres were present; they are at any rate insignificant, and the two chief layers explain all the motions which ensue in this division. The mucous coat in contraction of the organ forms many rounded folds. The glandular papillæ which clothe the surface of the latter—from the commencement of the region behind the translucent reservoir—almost, but not quite, to its cæcal tip, differ materially in structure from those of the previous parts. Viewed as a transparent object under moderate pressure (Plate X, fig. 12) the field is covered with globular glands containing clear rounded vesicles in their interior. In contraction, and when the wall is less compressed, the glands have a larger and coarser appearance, the external wall only of each being visible. When the pressure has been increased, these bodies, especially towards the posterior end (where, from their diminished numbers, a clearer view can be

[1] The appearances shown by this chamber (ϵ) in the extruded organ must not be mistaken for "poison-glands," since they are caused by the pressure of the glass cover rendering the central portion of the continuous umbrella for the moment indistinct.

obtained), alter their shape apparently by bursting (Plate X, fig. 13), and seem like minutely hirsute double rings, while the contained globules are scattered over the membrane. If the organ has been ruptured and partly inverted, the free edge of the laceration and the shrivelled glands are more easily observed (Plate X, fig. 21). The globules from the glandular papillæ (Plate X, fig. 17) and glands whose contents have been evacuated (rendering them minutely hirsute) readily pass forward to the reservoir, and roll through the ejaculatory duct—under pressure. The function of the vast array of glands in this chamber would seem to be the formation and elaboration of the peculiar fluid with the moving granules previously alluded to. This secretion is produced in considerable quantities, and towards the posterior portion frequently distends the cavity as a translucent pouch (Plate XI, fig. 16, *a*), wherein the granules are in full action, and even the experienced are apt to err in regard to the nature of the movements, so like are they to those caused by ciliary currents. Under a high power (700—1000 diam.) the molecules appear as mere specks or points ; and they retain their curious motion for upwards of twenty-four hours after extrusion from the cavity. There is thus a special fluid rich in these granules secreted by the posterior chamber ; and continued observation, and the whole anatomy of the parts, show that this fluid passes forward into the reservoir, where it is probably mixed with a small quantity of another secretion from the glandular walls of the latter, and then propelled with force through the ejaculatory duct into the anterior chamber. What its peculiar function in the anterior region, or when discharged into the surrounding medium in the extruded state of the parts, may be, can only be conjectured; but, from the elaborate structure of the tissues concerned in its economy, its action would seem to be important. I have no observations in support of the view that this granular fluid is poisonous. It cannot pass into a wound at any rate until the stylet is withdrawn; and if it really acts as a poison to animals when introduced into their tissues, it may reasonably be supposed to affect them injuriously when discharged into the water around them. Whether the liquid has any influence on the secretion of the stylets in the marginal sacs, or on the central apparatus, I am unable to say ; but, as already stated, a minutely granular fluid has been seen in the former, and stylets are not unfrequent in the posterior chamber of *A. pulcher*. MM. de Quatrefages, van Beneden, and others, state that the foregoing apparatus is used in attacking prey. I have never observed the Enopla so engaged, and it may be asked,—Do the Anopla use their feeble and unarmed structures for the same purpose? The proboscis in the Enopla, indeed, is a somewhat precarious aggressive weapon, for when extruded it frequently adheres to the irritating body, and is thrown off. It is true a predatory function may be assigned with an air of probability to the central stylet, but this cannot be done with those in the marginal sacs, for, being developed in a free condition within almost closed cavities, they are quite useless as offensive organs.

The walls of the posterior chamber, after forming the *cul-de-sac*, are continued backwards in the form of one or two long translucent muscular ribands of extreme flexibility and contractility (ψ, Plate XII, fig. 4), which are attached to the proboscidian sheath, rather behind the middle of the animal; the fibres spreading out in a fan-shaped manner, and mingling with those of the tube. The motions of these muscular bands is most interesting, now jerking into numerous graceful folds or coils by a sudden contraction, like the stalk of a Vorticella, and again shortening more gradually—the curves being here and there thickened by the swelling of the fibrillæ. They are simply muscular fasciculi, which seem to restrain the irregular protrusion of the proboscis, and assist in its retraction. This muscular arrangement is also the *ultimum moriens*, showing contractions when all other signs of life have fled. In young animals the mobility of the fibrillæ is so great that they become broadly clavate when ruptured from their attachments (Plate XII, fig. 10, ψ).

f. Varieties in the structure of the Proboscis.

Before reviewing the statements of previous observers with regard to the structure of the foregoing parts, a description of the peculiarities of the regions in other examples of the Enopla may be given.

In *Amphiporus pulcher* the anterior region of the proboscis has a pinkish hue, and numerous small clear globules at its commencement. The glandular papillæ in the anterior chamber are finer than in *A. lactifloreus* (which may be taken as the type), and their marginal globules less distinctly marked. In transverse section (Plate XI, fig. 4) the large and somewhat lozenge-shaped columns of the reticulated coat are connected with the outer layer (*g*), while a process from the opposite angle passes inwards towards the circular fibres (*c*), so as to cut the great longitudinal layer (*d*) into a number of separate fascicles, which, in the fine specimen figured, amount to fourteen. When the organ is turned inside out the usually thin external longitudinal coat is thrown into dilated segments separated by the processes from the outer angle of each lozenge-shaped column of the reticulated layer. The marginal stylet-sacs are very large (Plate XII, fig. 6, ν), and each contains, in well-developed specimens, from five to nine stylets, a large circular globule, and a granular orange pigment-mass, besides a fluid rich in moving granules, similar to the secretion of the long posterior chamber. It is, however, in the apparatus of the central stylet that the greatest deviation from the typical structure occurs. This (λ, Plate XII, fig. 7) is small, elliptical rather than ovoid, and its granules are very minute. In addition to the ordinary stylet (*a*) fixed to the anterior end, another (*b*) projects into its substance, enclosed in a kind of sheath, the point thereof extending forward almost to the butt of the anterior stylet. This reserve-stylet is not in all cases fully formed, but apparently awaits the rejection of its precursor for complete development. Its head lies in a large cavity constituted by a peculiar disposition of the fibres composing the investment of the basal apparatus and the region behind. Instead of the usual wedge-shaped structure, fibres radiate outwards from the sides of the organ, curve backwards, and arch over a large cavity (Plate XII, fig. 6, *ov*) filled with a clear fluid, part of the floor being formed by the anterior fibres of the reservoir. In certain states of contraction the reserve-stylet is thrust backwards, so that its butt rests on the latter chamber, a position quite easily attained, on account of the yielding nature of the cavity and tissues placed immediately behind and around it. Streaks, due to the granular glands, are also observed passing from the central apparatus along the arch of the fibres. The glands themselves are distinct enough if the specimen is not too much pressed. The great development of the cavity behind the central apparatus might be supposed to assist in the rapid formation of the reserve-stylet, yet it cannot be absolutely necessary for its development, since the stylet is as readily replaced in front of the granular structure in other species. The ejaculatory duct is large, and being surrounded by a very yielding region, is more mobile than in the typical form. The clear globules interspersed amongst the looped fibres of the reservoir are numerous, so that under examination the cavity seems covered with them; continued pressure causing them to escape into the reservoir, and pass forward into the ejaculatory duct. The curved fibres have a laminated appearance posteriorly. Circular fibres are clearly indicated in this species by the peculiar contractions of the inner wall of the reservoir (Plate XII, fig. 6). The latter has more translucent walls and greater mobility than in *A. lactifloreus*, and the coats are diminished in total bulk posteriorly, so that the channel of communication is short. The glands of the reservoir are large transparent structures, with clear globules in their interior, and differ in general aspect from any hitherto observed. Those of the posterior chamber of the organ are larger than in *A. lactifloreus* or *Tetrastemma*. Occasionally several stylets lay in the *cul-de-sac* of the latter division, showing that they had passed along the ejaculatory duct, or that the reserve-stylets had fallen into the cavity behind, and thence made way through the reservoir into the posterior chamber; unless we are to suppose they had been formed in the latter. When the proboscis of this species is everted (Plate XIII, fig. 19), the central stylet projects much less than in *A. lactifloreus*. The cavity behind the central apparatus becomes elongated, apparently by the encroachment of the marginal stylet-sacs. There is no appreciable space at the base of the central stylet, which (space) in *A. lactifloreus* forms the small umbrella (ϵ) in this position. The floor of the anterior chamber is less differentiated, and the spiral muscles of the reservoir less bulky.

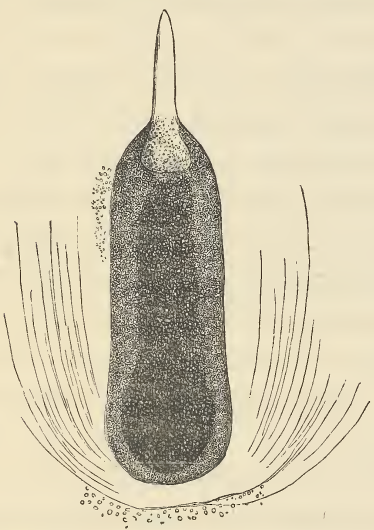
Dr. Johnston observes of this species, "that the structure of the stomach" (proboscis) "is like that of its congeners, excepting in there being five or six spines on each side of it, instead of three, which is the usual number." He does not refer to the peculiar arrangement of the central stylets, though an incomplete woodcut in one of his early papers shows that it had not entirely escaped the notice of his accomplished artist. In fig. 19, Plate C, of the 'Voyages de la Commission Scientifique du Nord, en Scandinavie,' the structure of the central apparatus of this species is also fairly shown.

The proboscis in *Amphiporus spectabilis* has a faint pinkish hue. My sole specimen was partially decayed before examination, but it was at once apparent that no extraordinary curved horny comb as described by M. de Quatrefages existed in the place of the central stylet. The author, however, does not speak with certainty on the subject, since he states that he regrets he had mislaid his drawing of the actual relations of this organ to the other parts. The whole structure is essentially that characteristic of the *Amphiporinæ*, as represented indeed by Professor Keferstein.

The organ is comparatively large in *Amphiporus hastatus*, and the glands of the anterior region coloured of a pale brownish or dull yellowish hue. The central portion of the stylet-region (Plate XXIII, fig. 18), has its basal granular apparatus very slightly constricted towards the posterior third. The muscular investment of this structure presents a pale brownish appearance by transmitted light, whereas it is usually colourless. Behind is a cavity homologous with that found in *A. pulcher*, but much less capacious. The region is peculiar in having four marginal stylet-sacs, which occupy nearly the same level in the organ at different points of the circumference, and thus the pairs are not separated from each other, as represented by M. de Quatrefages in his *Polia armata* (a *Tetrastemma*), by a considerable antero-posterior interval. Each sac has the usual appearance and size, contains two or three perfect stylets, some free granules, and is connected with the floor of the anterior chamber by a duct. The external granular glands are well developed, and there are many larger globules amongst the others, sometimes resembling a nucleus in the midst of surrounding granules. The peculiar elasticity of the fibres composing the longitudinal layer of the proboscis is conspicuous in specimens which have been kept some hours in water, and then placed under pressure. The ruptured fibres keep jerking and twisting in a very characteristic manner, the free margin of the organ being fringed with coils.

The anterior region of the proboscis in *Amphiporus bioculatus* is faintly pinkish, and the glands rather numerous and small. The basal apparatus of the stylet-region (Plate XXIII, fig. 19, and woodcuts, figs. 3 and 4), is much elongated, rather wide anteriorly, so as to have a nearly uniform diameter throughout, and rounded posteriorly. The constituent opaque-white granules are minute, while the head of the stylet is large. The muscular cavity (ε) behind the floor of the anterior chamber is small, and obscured by the external granular glands, for the latter extend both before and behind the basal apparatus under pressure. The other parts of the organ

Fig. 3.

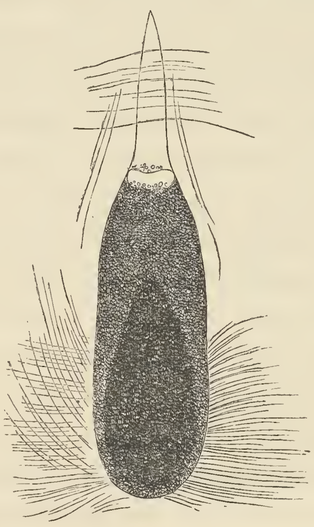


Central apparatus of the stylet-region of *A. bioculatus*. × 220 diam.

Fig. 4.

Isolated stylet. × 220 diam.

Fig. 5.



Central apparatus of the stylet-region of *Tetrastemma Robertianæ*. × 350 diam.

presented no noteworthy feature, except that no circular coat could be made out in the anterior region between the greater longitudinal and the mucous coats.

In *Tetrastemma melanocephala* the proboscis is somewhat larger than in *A. lactifloreus;* and exhibits certain important differences. The stylet-region (Plate XII, fig. 8) has the marginal sacs carried considerably forward, so that they lie quite in front of the central apparatus, and the floor of the anterior chamber has consequently to form a deep pit to reach the spike of the central stylet. The basal apparatus of the latter is proportionally large, while its wedge-shaped investment is comparatively meagre. The radiating or oblique fibres (near θ) which pass outward and forward from the latter, in the usual position of the organ under pressure, are very distinctly shown, and apparently sling the apparatus. The points of both central and marginal stylets (Plate XIV, figs. 8 and 9) are rather blunt, and their shape on the whole resembles that in *T. candida.* The circlet of granular glands is much developed, and often renders the subjacent parts obscure.

The remarks and figures of M. de Quatrefages relating to this species (his *Polia coronata*) require amendment. He mentions that it is the only exception he has met with to the uniform arrangement of the stylet-apparatus, as, in addition to the forward position of the marginal sacs, the central stylet and its surroundings are placed in his second œsophageal cavity, that is, in our reservoir; and his figure bears out his description, representing, moreover, the organ as placed at the commencement of the posterior channel. The species is easily identified by the position of the marginal stylet-sacs and other peculiarities, and there is certainly no such abnormality of the central apparatus or alteration of type as noted and figured by this naturalist.

In *Tetrastemma Robertianæ* the glands of the anterior division give the organ a faint pinkish colour. The middle region has two stylet-sacs of the usual structure, and a central apparatus (fig. 5) which differs from the ordinary form in *Tetrastemma* in being somewhat enlarged anteriorly. The stylets (Plate XIV, fig. 10, *a* and *b*) are short and stout, similar in shape to those of *T. melanocephala*, though decidedly smaller. Thus, while distinctions in the size and shape of these organs are valuable, they should not be too much relied on for specific separation. The external circlet of glands does not proceed further backwards than the posterior third of the basal apparatus of the central stylet.

The general arrangement of the proboscis in *Tetrastemma candida* agrees with that in *A. lactifloreus*. If under examination the ejaculatory duct is placed on the left of the central apparatus (Plate XIII, fig. 5), an explanation is obtained of the mistake into which M. Claparède had fallen in his description of the region in *Tetrastemma varicolor* Œrst. (the figure, however, appears to me to be very like that of *T. candida*). The central stylet and its apparatus have been slightly pressed backwards, so that the radiating fibres which sling them have been brought out distinctly, and sometimes a faint line of demarcation is seen on the right (in such a position)—simulating the presence of a separation; but numerous fibres are prolonged past this, and, moreover, a slight contraction or change of position obliterates the line, while the curved or radiating fibres are rendered more evident. On the left the only boundary to the supposed distinct coat around the wedge-shaped investment is the wall of the ejaculatory duct. The basal apparatus of the central stylet in this species (*T. candida*) has rather more shape than in *T. melanocephala*, and is proportionally more elongated (Plate XIII, fig. 6). I thought a slight difference could be detected between this species and *T. dorsalis* (Plate XIII, fig. 8, *c*), for the stylet in *T. candida* is generally shorter in proportion to the length of the basal structure. Considerable variations exist in the size of the several stylets in *T. candida*, independently of the magnitude of the animal, a fact perhaps the less surprising when the reproduction of the tube is remembered; but the greater size is generally diagnostic when compared with the three following species. The central and marginal stylets (Plate XIV, figs. 6 and 7) nearly agree in length. In a developing or recently repaired central apparatus (Plate XI, fig. 13) the basal portion is thinned off anteriorly from contraction of the parietes, and the difference in size between its stylet and one from the marginal sac of the same animal (Plate XI, fig. 14) is marked.

The stylet-region in *Tetrastemma dorsalis* is closely allied to that in the former species. The stylets, however, are on the whole more slender, and the central longer in proportion to its basal apparatus (Plate XIII, fig. 8). The same may be said of *T. vermicula* (Plate XIII, fig. 4).

The shape of the central apparatus in *Tetrastemma flavida* is characteristic (Plate XIII, fig. 9, *c*), the stylet being more slender than in the two former species, longer in proportion to the basal apparatus, and having the margins of the latter nearly straight. The comparatively large size of the glands of the reservoir in *Tetrastemma* is well illustrated in this species, where they form very prominent structures with granular contents, and more closely allied to those in the posterior chamber than in *A. lactifloreus.* The anatomy of the muscular and other tissues of the proboscis in *Tetrastemma* agrees with that in *Amphiporus.*

In *Prosorhochmus Claparedii* the stylet-region (Plate XIII, fig. 1) has the granules of the external circlet of glands unusually large and distinct. The basal apparatus of the central stylet has a straight border and sharp angles posteriorly, and obtuse angles at the sides. The pale investment of this structure is comparatively limited in bulk; and the curved fibres immediately behind sweep outward and forward very distinctly.

The size of the proboscis in *Nemertes gracilis* is greatly diminished in proportion to the bulk and elongation of the animal, the stylet-region, indeed, being found only a short distance behind the ganglia (Plate XII, fig. 11). The floor of the anterior chamber generally presents a bilobed aspect under examination, and has not the massive muscular structure usually found in front of the stylet-sacs; but it is furnished with a somewhat opaque mobile lobulated arrangement of glands, which, in extrusion of the organ (Plate I, fig. 6), appear as two semi-opaque whitish papillæ (one on each side), the stylet-sacs being prolapsed into their interior. The central stylet does not easily project in this condition. The stylet-region proper is somewhat opaque, on account of the glandular nature of the walls anteriorly, and the layer of granular glands posteriorly. The latter are placed far back, and in developing specimens form a granular mass on each side of the ejaculatory duct, sometimes entirely filling up the space (at *a*, Plate XII, fig. 11); and consist of a dense aggregation of minute clear granules, and coarsely lobulated glands, which are apparently homologous with the granular glands of other species. The marginal stylet-sacs have very long ducts, and each encloses from seven to ten stylets of a distinctive shape, besides other contents. The central stylet is appended to a basal apparatus of great length, its outline indeed resembling that of a long bone, such as the radius, the stylet being articulated to the head, while the distal extremity is represented by the dilated posterior end of the apparatus. The latter has the usual granular contents, but the exterior firm investment, so characteristically wedge-shaped in other species, does not proceed half-way forward, the slender anterior portion having only a thin covering for its support. While in ordinary views the stylet and apparatus seem straight, both have a decided curve in profile (Plate XIII, fig. 18). Just in front of the point where the clear investment of the apparatus becomes indistinct, the ejaculatory duct opens into the peculiarly elongated muscular cavity (ε), which extends forward to the circular opening in the floor of the anterior chamber. The channel shows a distinct inner layer of longitudinal fibres, which, however, seem to act only in company with the external oblique series surrounding them. The presence of this special coat demonstrates that it is not the mere doubling of the floor of the anterior chamber which forms the cavity, as indeed certain appearances, previously observed, had led me to suspect. The central and marginal stylets have the same shape, and the majority agree in size. In its usual position the stylet has the form of a spear-head (Plate XI, fig. 15), being sharp-pointed, then dilating gradually till near the posterior end, where a slight diminution occurs, and then a marked constriction—just in front of the somewhat small head. If minutely examined, both central and marginal stylets show a small secondary swelling or ring above the latter. The ejaculatory duct is comparatively large and distinct, comprising posteriorly almost the entire region of the reservoir, a slight demarcation, however, marking off the dilated extremity into a portion pertaining to the latter cavity, and another to the division in front. The widened posterior end is covered with small glands, which are continued along the tube to its opening in the muscular chamber behind the floor. One peculiarity in the elongated reservoir is the comparative thinness of the spiral fibres anteriorly, and the thickness of the longitudinal layer, which seems to afford compensation for the diminished strength of the exterior coat. This deviation from the usual structure is doubtless in connection with the enlarged posterior end of the ejaculatory duct, and the gradual blending of the cavity of the reservoir into it. The mass of the spiral fibres is grouped posteriorly, and in action would seem to compress the reservoir, so as to throw its contents forward to the gaping aperture of the duct. On this account also (*i. e.*, the grouping of the looped fibres posteriorly), the channel of communication is long. The external layers, continued from the preceding division, pass about half-way backwards over the reservoir. Another peculiarity is the presence of numerous clear cells and granules amongst the spiral fibres. Some of the cells contain nuclei; others do not. The glandular papillæ in the interior of the reservoir are large and prominent. The very great length of the posterior chamber, as compared with the short anterior, is noteworthy.

M. de Quatrefages seems to have devoted considerable attention to the anatomy of the foregoing species (his *Nemertes balmea*). He represents the stylet-region as having the marginal sacs rather behind the long central granular apparatus, each of the former possessing a carunculated gland attached to its posterior end, while the latter has two longer structures of the same description. None of these carunculated appendages have been seen by me, since it can scarcely be supposed he refers to the opaque granular condition of the space (at *a*, Plate XII, fig. 11)—previously described. His account of the contents of the marginal stylet-sacs is erroneous; for though the position of the stylets is of no moment, the assertion (and corresponding figure) that each has a developing basal apparatus attached to its extremity does not rest on facts. The outline of the stylets given by this author is inaccurate, since no constriction is represented in front of the head, and no mention made of their curvature. The other objections to his views are noticed elsewhere.

In *Nemertes Neesii* the proboscis, while approaching that of *N. gracilis* in general size, and the tenuity of the posterior region, is yet more closely allied to *A. lactifloreus* in the structure of its comparatively short stylet-region proper (Plate XII, fig. 12). The floor of the anterior chamber is furnished with very minute glands. The marginal stylet-sacs are small and somewhat rounded, their ducts being occasionally spindle-shaped, from evident constrictions situated respectively at the openings into the floor of the anterior chamber and the sac itself. The stylets are at once distinguished by their short, stout form, and peculiar markings resembling the longitudinal streaks in polished mahogany (Plate XI, fig. 12), which are due to irregularities or furrows on the surface. The granular basal apparatus of the central stylet (λ, Plate XI, fig. 11) is short, and has only a slight constriction in the middle, so that the lateral line, from the apex of the spike to the base of the former, is nearly straight. The opening of the ejaculatory duct into the cavity (ϵ) behind the floor of the anterior chamber is wide. The reservoir is much elongated, and it may be observed that its soft fibres, as pressed between glasses, do not appear in a spiral series down the sides of the cavity, but in the form of a dense felt-like arrangement; yet, when freed from pressure, their elaborate crossings are better shown than in most species (Plate XIV, fig. 5). In the same region the longitudinal fibres are much developed anteriorly, though they are only well seen on stretching the parts, otherwise the felt-like arrangement of the spiral fibres obscures them. The glands of the reservoir are smaller and less distinct than in *N. gracilis*, especially anteriorly. The channel of communication with the posterior chamber is short and wide, and in marked contrast with the same part in the latter species. The long posterior chamber has its inner surface thrown into very prominent rugæ, which sometimes appear like large papillæ covered with the characteristic glands of the cavity. These plaits are not mere wrinkles and folds caused by the contraction of the organ, but are present under great pressure (Plate XII, fig. 13). The granules of the peculiar fluid therein are also conspicuous. It may here be mentioned that after prolonged confinement the integrity of the proboscis in this and other species is affected, the stylets degenerating, and even disappearing altogether, both from the central and marginal structures. Not only is this the case in the adults themselves, but under the same circumstances the more advanced young in the interior of *Prosorhochmus Claparedii* undergo a like degeneration. In a specimen of *N. Neesii* where this had occurred, the wave of the molecular fluid driven forward by the contraction of the reservoir distended the muscular cavity (ε) at the front of the granular basal apparatus (which in this instance was devoid of a stylet); and as the aperture into the anterior chamber permitted only a limited discharge at a time, the fluid rushed into the centre of the granular structure, and distended it and its wedge-shaped setting with every impulse. The absence of proper nutriment and free aëration, for the salt water was but rarely changed during the year, are sufficient causes for the above-mentioned degeneration.

In *Nemertes carcinophila* the proboscis and its apparatus are reduced to a minimum. The anterior region (Plate XII, fig. 14, A) is very short, and has an almost conical outline, the base of the cone being formed by the floor of the chamber. Its wall is proportionally thick and muscular, and the tube has a granular aspect internally, a condition probably due to indications of papillæ. Posteriorly it terminates in the usual floor, into which, however, only one aperture leads, viz., that of the central stylet. The stylet-region, while still retaining the type of the Enopla, differs much from that of any other British species. Instead of the ordinary well-defined arrangement of longitudinal and radiating fibres, the entire muscular structure is obscured by numerous granular or cellulo-granular bodies (γ). There is no trace of marginal stylet-sacs. The central stylet is minute, and furnished with an elongated and faintly granular basal apparatus, which is fixed in the usual transparent muscular investment. The mobile chamber (ε), into which the ejaculatory duct opens, is in the ordinary position. Though the whole apparatus is very minute, the stylet has been observed to be thrust forward by the contraction of the fibres of its basal investment, so that its point projected into the anterior chamber of the proboscis. The ejaculatory duct is large, and, from its central position in ordinary examinations, causes the stylet-region proper to appear bifid posteriorly; but this is due only to the greater translucency of the duct, which, for the time, makes a separation between the dense granular masses at the sides. The region of the reservoir is fairly developed, the wall being formed chiefly of muscular fibres having the usual spiral arrangement, and the inner surface covered with granular glands. Occasionally the reservoir contracts with force, and drives the contents forward into the ejaculatory duct and muscular space behind the floor of the first region. The channel of the reservoir leads into a posterior chamber of comparatively small dimensions, but having rather thick walls, and terminating in a *cul-de-sac* and bulbous end a short distance behind the œsophageal apparatus of the animal. The cavity has a cellulo-granular lining internally, and in some specimens the terminal portion is distended by a transparent fluid containing a few compound cells of similar aspect to those found in other species. It is kept in position by fibres from the strong bands at the posterior part of the œsophageal region of the digestive chamber. All M. van Beneden states with regard to the structure of this organ is that it is very short, and bears an "isolated" stylet. He also represents certain lines, which indicate a sheath (*cul-de-sac*) around the proboscis, a state that has not been seen in our examples.

g. Review of previous Interpretations of the Proboscis.

The proboscis was held to be a genital organ by some authors, as Huschke, Quoy and Gaimard, and Œrsted; others, *e. g.*, Ehrenberg, Johnston, De Quatrefages, Williams, Busch, Leidy, Girard, and Stimpson, maintained that it was the digestive canal; while H. Rathke called it an organ of touch. Some, again, have mistaken it for a parasitic worm, or a Nemertean embryo. Amongst those who have studied its anatomy in the Enopla, M. Ant. Dugès considered the organ to be part of the digestive system of his *Prostoma armatum*. He observed the stylet-sacs and their contents, which he described as six hard transparent points, disposed in two groups, while the central apparatus consisted of a horny oblong piece of a brownish colour. He thought the central organ would pierce the skin of the annelids on which the animal might prey, while the lateral points would retain them captive; and, moreover, that such an apparatus approached the hooks pertaining to parasitic worms, *e. g.*, *Polystomes* and *Echinostomes*.[1] He sketched rather rudely the structure of the organ in one of his plates,[2] and it is evident he was acquainted with the three regions; moreover, a sheath for the proboscis is indicated in his drawing.

In Gaimard's 'Voyages de la Commission Scientifique du Nord, en Scandinavie,' the anatomy of the proboscis in the Enopla is represented with considerable accuracy. The papillary lining of the organ is separated from the external layers. The central stylet, however, is placed far back, and no special floor of the anterior chamber is formed, the apparatus being enveloped in a broad mass of circular or transverse fibres, but the clear muscular investment is definitely figured, and there are longitudinal fibres posteriorly. Over the reservoir spiral fibres are clearly indicated, and the posterior region has at least two coats. Moreover, ducts to the marginal stylet-sacs are shown, and though they are two instead of one in each, yet their presence is thus early indicated. In Plate E, fig. 11 of this work, a single duct proceeds from each marginal stylet-sac, and, after a short course in a direction forward and inward, it divides into two branches, one of which communicates with the floor of the anterior chamber, and the other slants inwards and somewhat backwards to open into the ejaculatory duct. The proboscis is also figured in an extruded condition (Plate E, fig. 15), but the structure of the stylet-region in this position has been erroneously delineated. The artist represents the central granular apparatus and the stylets throughout very fairly.

The minute anatomy of the organ given by M. de Quatrefages is somewhat inaccurate. I have not observed that the dilatations and contractions of the channels of the reservoir (his œsophagus) vary in the manner he refers to in different species. He describes two swellings of this "œsophagus," a large lozenge-shaped one at its commencement, and another corresponding to our reservoir, these dilatations being connected by a straight channel. The former may have

[1] The stylets of the Nemerteans seem to me to have as little analogy or homology with such structures as with the "crystalline styles" in the stomachs of certain mollusca.

[2] 'Ann. des sc. nat.,' 1re sér. Zool., tom. 21, pl. ii, f. 5.

some connection with the mobile muscular chamber behind the stylet-aperture in the floor of the anterior region, but his descriptions and drawings are indistinct. He aptly likens the two central divisions (stylet-region) to crystal; but he says he required the action of hydrochloric and acetic acids to distinguish fibres, which, he observes, have a transverse direction, and he especially notes that he could not make out any longitudinal fibres. I have always been able to see these fibres in the fresh and living specimens, without any addition to the sea-water in which they happened to float; and, moreover, the presence of longitudinal, spiral, and other fibres, previously described, show how much more complex the structure is than the author imagined. He correctly reports the absence of vibratile cilia from this region; but he errs by affirming that they occur in the posterior chamber. His figures of the stylets differ from any seen by me, since they exhibit a swelling and then a contraction in front of the head. The basal apparatus is termed the "body" of the central stylet, and he narrates how in *Nemertes balmea* (*N. gracilis*, Johnst.) this body has an exterior coat composed of the same structure as the point. Nothing more than the usual firm muscular investment is really present (see p. 67). Again, the statement that the "body" acquires greater solidity is not borne out in fact, for the granular contents of the apparatus are homogeneous throughout. He speaks of a pouch containing a granular glandular substance in which the stylet and its "body" are placed in this species, and thinks it probably secretes the latter (body); and, though he has not seen it in *Polia*, he considers its existence likely. The author has evidently fallen into confusion here, for the granular structure (or so-called "body") is fixed in a clear investment of the firm muscular substance. He next describes and figures other two cavities, which are said to exist at the borders of the "stylet-pouch," semi-opaque and glandular in *N. balmea*, very transparent in *Polia;* and he considers that these two glandular organs secrete a poisonous fluid, for use in offence and defence, which (fluid) is poured into the pit in front of the stylet-region. Entomostraca, moreover, were killed instantaneously by wounds of the stylet, an effect which could not be due to mechanical injury only, but to the presence of an active poison. It is true he was not able to distinguish these glands or their cavities in many species, so that, if they existed, they must have been confounded with the neighbouring tissues by reason of their transparency. Such glands have never occurred in the British species, and the opaque granular substance really present in *N. gracilis* (*N. balmea*, Quatref.) totally differs in structure and function from his representations. The folding downwards of the floor of the anterior chamber, and the presence of the muscular space behind, have probably caused the mistake; and, indeed, it may be remarked, that the time and opportunities necessary for a correct appreciation of these complex structures make those best acquainted with them least surprised at such errors. The two muscular bands, also, which M. de Quatrefages figures and describes as for the probable purpose of carrying forward the stylet-apparatus, and compressing his hypothetical poison-glands, have not been seen, and the explanation of the parts already given renders such useless. With regard to the observations that the marginal stylet-sacs are free in *N. balmea*, but placed in the thick walls of the "œsophagus" in *Polia*, I can only state that the type of structure is the same in all, and that they occupy corresponding positions in the species referred to. It is probable also that the finding of only one marginal stylet-sac in *Polia quadrioculata* and *P. humilis* was accidental, and not by any means characteristic of such species (*Tetrastemmæ*). The remark, that in *Polia vermiculus* one sac is placed on the dorsal and the other on the ventral surface, is of no consequence when the ever-changing condition of this very mobile organ is remembered. The author further describes the "intestin" (our posterior chamber) as having the same coats entering into its composition as the anterior region, though, he adds, the muscular layers are proportionally thinner. As already stated, the structure of the walls of the two regions is essentially different, just as their functions disagree. He is correct in averring that the cavity ends in a *cul-de-sac;* but wrong in saying it is ciliated, and that the terminal ribands are attached "à la paroi abdominale." Lastly, he is only certain of the muscularity of these ribands in *Polia coronata* (*Tetrastemma melanocephala*), and he gives a curious figure (which cannot be verified in our specimens) of their termination as a series of arborescent fibres. This author also considered that the marginal sacs secreted stylets for the supply of the central apparatus.

Dr. Johnston's description of the stylet-region is as follows:—"First, we perceive on each side a small circular spot or cavity, in each of which are three spines with their sharp points directed outwards; beneath these there is a cup-shaped organ encircled above with a faintly plaited membrane, and armed in the centre with a strong spine, which can be compared to nothing more aptly than a cobbler's awl in miniature, the part representing the handle being very dark, and the point transparent and crystalline. This apparatus is placed within the intestine, is visible only when this is compressed, and is, as I believe, stomachial, having some distant analogy with the proper digestive organs of Laplysia and Bulla." His anatomy is thus imperfect; and he, moreover, held the opinion that the "intestine," as he termed the organ, proceeded to the tip of the body and terminated in a distinct anus.

Dr. Thomas Williams observes with regard to the proboscis (his digestive tract):—"The extremity of this organ is armed with several styleted jaws, which, from their construction, seem only designed to fix the suctorial end by perforating the alimentary object. When the proboscis is withdrawn into the interior of the body, fitting admirably into a short œsophagus, these sharp instruments are packed and folded upon themselves," the sides of the tubes closing round them. The correct examination of a single extruded organ would have at once dispelled such notions. His supposition, that the glands in the interior of this structure furnish an important secretion for the digestive process, which secretion is exuded into the "œsophagus" (apparently, judging from his figure, the proboscidian sheath), and thence into the great alimentary organ, rests upon no facts. He also errs in stating that the outlet of this organ is situated not far from the cephalic end of the body; but his remark, that there is no open communication between the œsophageal tube (proboscidian sheath) and the "alimentary cæcum," is correct.

Dr. Max S. Schultze, in his account of *Tetrastemma obscurum*, gives no definite description of the ending of the proboscis, and figures the central stylet as projecting freely into the cavity. He indicates the presence of the muscular space behind, but confounds its structure with the wedge-shaped investment of the basal apparatus, the whole forming, he remarks, a quadrangular mass. He erroneously describes the terminal ribands as attached to the wall of the body. In his figure he omits to notice the ducts of the marginal sacs, though he regards the latter as the producers of the stylets for the central organ. He first indicates, however, the connection between the developing spikes and the clear globules in the marginal sacs, showing that they are sometimes seen in their interior. Finally, he has not discriminated the structure of the reservoir and its relations to the neighbouring parts; and, indeed, his anatomy of the organ, from the limited nature of his observations, is somewhat imperfect. These remarks apply to his 'Beiträge,' as well as to his more recent representations in the 'Icones Zootomicæ.'

M. Claparède describes, in his 'Recherches Anatomiques,' the apparatus of the central stylet in *Tetrastemma varicolor* as set in a pale space of a triangular form, and he leaves the stylet-apparatus to hang therein, apparently by its anterior end. He has mistaken the translucent wedge-shaped investment of the organ for a cavity, and the triangular muscular structure to the exterior is imperfectly figured. He correctly observed the presence of a duct to each marginal sac; but supposed that these pouches were for the lodgement of stylets discarded from the central organ, and hence saw no connection between the clear globule and the developing spikes therein. His representation of the muscular fibres of the stylet-region is faulty. He discovered the presence of a liquid containing minute granules in the reservoir, and stated that the latter communicated with the "Trompe" by means of an efferent canal; but he fell into the error of regarding the posterior chamber of the proboscis as a "muscle retracteur." His delineation of the opening of the ejaculatory duct is inaccurate, from the absence of the muscular cavity behind the floor of the anterior chamber. The reservoir is regarded as a poison-gland, which squirts its contents along the ejaculatory duct into the wounds inflicted by the stylet. In his more recent 'Beobachtungen' he exhibits the structure of the region in *Prosorhochmus Claparedii*, but gives no details of the anatomy of the muscles. The central stylet and its apparatus are placed in the middle of a continuous and apparently homogeneous body, the wedge-shaped envelopment of the basal organ and the muscular cavity in front being confounded. The opening of the ejaculatory duct of the "poison-gland" (reservoir) has the same position as in his previous figure, viz., at some distance from the stylet, and passing directly into the floor of the anterior division. He now refers to the posterior chamber, which, he says, occupies the centre of *the muscle of the organ*, a modified but unsatisfactory description. The external granular glands are not characteristically figured.

In his anatomy of the region in *Polia obscura* (a *Tetrastemma*), M. van Beneden represents no ducts to the marginal stylet-sacs, and no ejaculatory duct. The reservoir has a cavity in the centre, but is likewise furnished with two hypothetical oval vesicles or spaces; while the muscular structure, the floor or ending of the anterior chamber, and other important points, are absent. The statement, that the marginal sacs contained stylets of a smaller size than the central, and of a different form at the base, is also ambiguous. He calls the former sacs pouches of replacement. While he asserts that the proboscis is enclosed in a separate sheath, he distinctly adds, that its muscular retractor is attached to the skin of the animal posteriorly; and that there may be no misunderstanding, he repeats the statement when drawing up his conclusions, by averring that the internal surface of the proboscis is ciliated, and that it is fixed to the bottom of the digestive tube by a retractor muscle, like the stomach of the Bryozoa.

So far as they go, Prof. Keferstein's remarks on this region in *Polia mandilla* (*A. lactifloreus*) are in advance of his predecessors. He does not mention, however, the minute glands on the floor of the anterior chamber, and represents the aperture for the central stylet much too large, so that in extrusion the muscular space (ϵ in our figures) becomes obliterated. The investment of the granular basal apparatus is continued too far forward in his drawing. He indicates no oblique fibres from the pit of the anterior division, is unaware of the complex anatomy of the proper stylet-region, and represents the coat of the reservoir as composed of longitudinal fibres. The external granular glands are not distinctly described; and the disproportion between the central and marginal stylets is so great, that probably some slip has occurred in their delineation. Lastly, his crenated border (external elastic coat) does not pass the constriction between the proper stylet-region and the reservoir, whereas both this and the longitudinal coat beneath are really continued some distance on the latter. His representation of the extruded organ is also much in need of amendment.

D. *Reproduction of the Proboscis.*

This has been observed in various species. In a specimen of *Tetrastemma melanocephala*, from which, three days before, the proboscis had been removed, there existed a pale conical papilla, which projected a short distance behind the ganglionic commissures. Two days after considerable progress has been made, and the organ proceeds backwards as a slender rod—tapered posteriorly (Plate XIII, fig. 2, *a*). There is a distinct exterior coat from one end to the other, and an inner—terminating at the commencement of the posterior narrow portion. The former has a crenated edge in contraction. The organ gradually increases in size and complexity, but continues quite free posteriorly for a considerable time, until, indeed, the stylets are well developed. At a further stage (Plate XIII, fig. 3), the walls are defined almost as in the complete structure, but of course are much more delicate and plastic; and the extreme contractility and elasticity of the entire organ are most interesting, and raise a doubt as to the identity of the muscular fibres with those of the higher invertebrates, since they so much surpass them in mobility. The floor of the anterior chamber ends in the usual pit, which is dilated on account of the shortening of the organ. The walls of the muscular cavity behind the floor of the anterior region are not well defined, though the space itself is large, and contains a granular fluid. There is no central stylet, and the basal apparatus is represented by a somewhat triangular group of the usual granules, round which the radiating fibres are placed. The wedge-shaped investment within the latter (fibres) is mobile and translucent. A somewhat indistinct streak (*f*) in the median line indicates the canal for the central stylet, and now and then this is bulged by projected fluid. The marginal stylet-sacs, from the expansion of the chamber in this instance, seem to be carried backwards, but in reality they have their distinctive position. Each contains a stylet or two, a few granules, and a clear globule.

The reservoir at this stage has assumed its characteristic shape, though the glands are barely visible. The contraction of the anterior and posterior chambers has annihilated the usual prominent appearance of this part, and the last has encroached very much on the cavity posteriorly. The glands are formed in the posterior chamber, though their contents are not elaborated, and the cavity terminates in the usual *cul-de-sac*. A few rounded papillæ at the termination indicate the early condition of the muscular riband. It is clear that at some time or other the latter becomes attached to the wall of the proboscidian sheath, and that, too, in a definite manner, since no great deviation in a series of specimens is met with.

In the developing organ of *N. gracilis* (Plate XIII, fig. 17) a very good analysis of the somewhat complicated structure is obtained, so that doubtful anatomical points are cleared up satisfactorily. The apparatus at the base of the central stylet is sometimes composed of granules in rounded masses; and they are all grouped posteriorly at an early stage, thus presenting a similar form to that seen in other species which have short structures in the complete state. It is curious to witness the accuracy with which the stylets are reproduced in this and other species. There is never any confusion, but each invariably develops them of their respective sizes and curves as infallibly as if they had been struck out of the same mould. Yet these bodies are not in any way organically connected with the tissues of the proboscis, but only spring from a secretion poured into the marginal sacs, or from the central apparatus. In the concentric arrangement of their constituent substance, and some other particulars, these spicula are analogous to those of the sponges, whose microscopic anatomy has been so excellently investigated by Dr. Bowerbank. Indeed, the morphology of the stylets in the Enopla offers elements for deeper reflection than even the hooks and bristles of the higher annelids, which are often so diagnostic of genus and species.

Besides the developing organ the proboscidian chamber contains (unless in cases where it has been violently expelled) the rejected proboscis; and it is an interesting sight to observe a fully-developed structure floating freely in the chamber, and still endowed with contractile power, while the new proboscis has advanced to the stage of the advent of stylets. The discarded organ soon becomes opaque, appearing reddish by transmitted light, and the stylets leave their positions. As there is no mode of exit after the new proboscis has begun to develop, the aborted one can only (not to speak of rupture) be removed by disintegration and absorption; and hence in the proboscidian chambers of such animals there is a vast increase of cells, granules, and granular débris.

6. Digestive System.

a. The Mouth.

Dr. Max Schultze, almost alone amongst foreign authors, seems to have noticed the true position of the mouth in his *Tetrastemma obscurum.* It forms a slit on the ventral surface immediately behind the aperture for the proboscis (Plate III, fig. 8, *w;* and Plate XIV, fig. 11, *w*). The two openings are especially distinct in *Amphiporus hastatus* and *Prosorhochmus Claparedii.* In animals which have been subjected to chloroform, the œsophageal apparatus is occasionally prolapsed through the mouth under pressure. The observations on this point have been often repeated, out of deference to the distinguished continental authors who hold different views, but I have never seen any deviation, and it is hard for the oral aperture to exist in the free portion of the œsophageal apparatus behind the ganglia. There is thus a marked distinction between the Enopla and the Anopla, the mouth in the first group opening quite in front of the ganglia, while in the other it is situated considerably behind the ganglia.

b. Œsophagus.

Though no transverse muscular plate, as described by M. de Quatrefages, occurs at the anterior part of the body of the worm, yet there exists a very distinct and comparatively large ciliated œsophageal chamber. The figures of the supposed transverse plate, indeed, given by the French author, show a degree of doubt, since in one drawing both wavy and longitudinal fibres are represented, while in another there are only transverse fibres. The wavy and longitudinal lines no doubt owe their presence to those actually existing in the œsophagus. Dr. Johnston indicates this structure in a figure of *T. melanocephala,* and he refers to it under *A. pulcher* thus:—"Immediately under the hearts" (ganglia) "we observe a large, somewhat muscular viscus, apparently hollow, and lying in the course of the intestine, but seemingly unconnected with it. Of its office and nature I can form no opinion; but I may remark, that in all the species a greater duskiness in its site shows that a similar organ exists in all." Professor Keferstein's notice of the organ in *Œrstedia pallida* is very brief; and he has abstained from figuring its relations, though affirming that its opening (constituting the mouth) is on the ventral surface behind the ganglia, as in the Anopla. M. van Beneden, while indicating an outline of the structure in *Polia capitata,* makes no reference thereto in his descriptions. The same omission is made by M. Claparède in regard to his figure of *Prosorhochmus Claparedii.*

In all the Enopla the œsophageal organ is easily observed (Plate XIV, fig. 1, *j*) as an elongated structure, occasionally tinted of a pale reddish brown colour, slightly narrowed posteriorly, and usually thrown into various longitudinal wrinkles. It diminishes somewhat abruptly behind the ganglionic commissures, and passes forward beneath the inferior one to the oral aperture at the ventral border. The narrow anterior channel for the proboscis lies close above the œsophagus towards the anterior part of the snout (Plate X, fig. 3). The two tubes become more evidently separated in most sections just in front of the ganglia, and the interposition of the broad inferior commissure soon renders the distinction more apparent (Plate XV, fig. 1); thereafter they have the tunnel of the proboscis as a party-wall, together with that portion of the extra-proboscidian region in which the median blood-vessel is situated. The œsophagus, moreover, occupies a special chamber, bounded by a series of well-marked fibres (Plate XI, fig. 2, *k*), which pass downwards from the upper wall by the side of the proboscidian sheath, and unite in the median line below it. The anterior narrow portion is translucent, and close behind the commissure a wrinkled arrangement is often seen, which is followed by the more opaque portion with its deep longitudinal rugæ. The former appearance is very similar to that which is caused by tying the mouth of a leather bag, and is due to the glandular folds and constriction of the organ in front. The pale division behind the ganglia shows active ciliary motion, but there is no trace of an aperture; indeed, the great and peculiar stretching of this pale portion, as it is dragged backwards from the region in front of the ganglia, at once demonstrates the fallacy of supposing it connected with any post-ganglionic aperture. The wall of the organ evidently contains some contractile circular fibres, which cause it to dimple inwards here and there during its motions; and in anterior transverse sections the ends of longitudinal muscular fibres are distinctly shown, though they are finer than those of the proboscis. Posteriorly the œsophagus opens into the alimentary cavity; but the communication is not actually seen in ordinary views, and I have not been able to observe the animals feeding.

The wall increases in thickness after passing the narrow portion in front, and again slightly diminishes posteriorly. In transverse sections of specimens hardened in spirit and mounted in chloride of calcium the structure has a streaked and fibrillated aspect (Plate XIV, fig. 12), being marked by a series of vertical striæ, and minutely granular, an appearance due to the position of the glandular follicles with respect to the inner surface, and the change caused by the preparation. It will also be noticed that in these sections the structure is thrown into numerous characteristic longitudinal folds. In the living example the inner edge of the organ (Plate XIII, fig. 20, *a*) has a somewhat translucent and well-defined border, garnished with moderately long and most vigorous cilia; indeed, the latter and the wall retain their irritability a considerable time after the death and partial decay of the animal, just as Darwin and Dugès observed in the proboscis of Planaria. The inner surface in the fresh specimen is always thrown into numerous wrinkles, and crossed by pale streaks—the ciliated edges of the folds (*b*). The entire structure is studded internally with a series of granular glands or follicles, which taper towards the free ciliated edge of the rugæ, and numerous brownish pigment-granules.

In *A. pulcher* the granular glands of the œsophagus are distinct and large; and in *T. melanocephala* the organ is curiously narrowed posteriorly. In *Nemertes carcinophila* it is short, nearly globular under moderate pressure, and presents a very distinct terminal aperture. It is also conspicuously tied in this species by strong transverse bands posteriorly.

This ciliated glandular œsophageal region is physiologically and homologically an organ of great interest. It is peculiar to the Enopla in the condition just described, since what is shown here in the complete form is only indicated in the Anopla by the turning inwards of the margins at the junction of the two regions of the alimentary canal. The granular glands and cells which coat the latter in *Amphiporus* arise on the sides considerably in front of the posterior end of the œsophageal division (Plate XIV, fig. 1), being collected in transverse section (Plate XI, fig. 3) chiefly on the ventral surface of the organ. The first (œsophageal) region, besides, occupies a special space in which it rolls. Its rich ciliation, and the somewhat indistinct ciliary movements seen in the posterior division of the alimentary system, are points of importance when contrasted with the arrangement in the Anopla, and show that from structure to structure essential differences between the groups meet the inquirer at every step.

c. The Digestive Cavity Proper.

After explaining the hypothetical transverse diaphragm, to which I have already alluded, M. de Quatrefages proceeds to observe—"Le reste de la cavité générale occupe tout le corps proprement dit; mais les cloisons verticales auxquelles sont suspendus les organes générateurs le partagent en trois chambres distinctes, l'une médiane, qui renferme le tube digestif dans une portion de son éntendue; les deux autres latérales, dans lequelles flottent les ovaires ou les testicles, et qui à l'époque de la reproduction se remplissent d'œufs ou de zoospermes." In his figures the scalloped shaded portion, which he terms "ovaires ou testicles," is, as Professor Keferstein pointed out, the glandular wall of the digestive cavity. Thus the very same organ is made in the one case ovary, and its gland-cells developing ova, and in the other respectively testicle and sperm-cells. Dr. Johnston recognized the structure as "a close series of vesicles or cells, formed in the true *Nemertes*, apparently by the folds of a membrane." The cæca, he adds, are always full of some opaque matter, which varies "in intensity at least according to the nature of the animal's food." He thought the structure was connected with the digestive system, though not in communication with the proboscis (his alimentary organ). Dr. T. Williams had also an inexact idea of this cavity, for he speaks of it as a great spongy mass, or "great alimentary cæcum," which commences anteriorly immediately behind the hearts (ganglia), under the character of a cæcal end, and as "a perfectly closed sac, containing a milky fluid." The walls of this cavity, he states, act upon the exuded food, after its passage through the coats of the "œsophagus." He is correct in denying the ovarian character of the organ, and in showing that the so-called ova consist only of oil-globules. Dr. Max Schultze described it as a straight canal in *Tetrastemma obscurum*, ciliated on its inner surface, and opening anteriorly and posteriorly; he also figures its cells—altered by extrusion into the water.

The digestive cavity in the Enopla is a somewhat moniliform or pinnate canal, in so far as its surface is increased by the numerous diverticula, which are best observed on the ventral surface. It appears under pressure in *Tetrastemma* (Plate XIV, fig. 1) as a lobulated glandular organ, usually of a pale flesh or slightly pinkish hue, extending almost from the ganglia to the tip of the tail, and forming (in the individuals in which the reproductive elements are not developed) a lining to the body-wall, except where interrupted by the proboscidian sheath. In the ripe animal, however, the gradual enlargement of the ovaries or sperm-sacs pushes in the yielding organ, so that it occupies a more median position, and has its ventral portion increased in bulk. It is also well to bear in mind that the body of the adult worm is only rounded in contraction, and partly so when the ova or spermatozoa are mature, but at other times it is flattened, and very mobile; thus, what is space in the transverse section is often obliterated in the living animal by the collapsing and contraction of the yielding tissues in the neighbourhood. Anteriorly the only opening leading into this chamber is that of the end of the rugose œsophagus; posteriorly it terminates in an anal pore, which is less easily seen than in *Lineus*, from the absence of the strongly ciliated internal streak. In intimate structure the walls of this cavity resemble the anterior or œsophageal portion, only the gland-cells are larger and more numerous, and the fatty elements in greater abundance, so that, although the type of structure remains, there are considerable differences in microscopic appearances. I was for some time in doubt about the ciliation of this chamber in *Amphiporus*, since I have seldom been able to see cilia satisfactorily in the uninjured *A. lactifloreus*, though in the latter, *N. Neesii*, *Tetrastemma*, and especially *Nemertes carcinophila*, peculiar motions of the cells were apparent. When a specimen is kept some time under pressure, moving granules are observed at particular points; these continue to increase in number, and sometimes a few cells accompany them, the groups gradually enlarging and revolving with great velocity. Such motions are doubtless due to the ciliation of the chamber. On making a transverse section of the living animal (*A. lactifloreus*), the inner margin of the digestive cavity causes motion in the surrounding particles, but the cilia are indistinct, and the appearances very different from the richly ciliated tube of *Lineus*, or its œsophageal portion anteriorly. It is thus much more feebly ciliated than the others.

In the walls of this complex cavity are a vast series of gland-cells, which, with M. van Beneden, I consider have some analogy with the liver of the higher forms, notwithstanding the adverse opinion of Prof. Keferstein, who, however, probably refers more particularly to the Anopla. The cells (Plate XX, figs. 7 and 8) have an average diameter of $\frac{1}{800}$ of an inch, and consist of a delicate membrane containing a number of granular fatty bodies. After extrusion from a living specimen into salt water, a remarkable movement, which the observer is apt to attribute to cilia, occasionally ensues in the contents before breaking up. The contained bodies jerk about within the cell, and soon a number of very minute granules appear, having burst from the former, in which their presence is indicated by obscure markings. The peculiar motions would seem to be due, as usual, to the action of the water, and ultimately the minute structures are all set free. The various appearances of the contents of the cells are shown in Plate XX, fig. 9, some being granular, others presenting faint concentric lines like starch-corpuscles (though probably fatty), while three oil-globules are indicated on the right. The deep port-wine oil-globule is somewhat sparingly scattered throughout the wall of the tract, the yellowish-red being abundant, and the pale globule still more plentiful. These cells have a similar structure in *Tetrastemma* (Plate XIV, fig. 13), and often escape under pressure posteriorly. The quantity of deep yellow oil in this organ in *T. candida* is unusually great. The glandular structure just mentioned undergoes partial absorption at the period of reproductive activity, so that after the deposition of the ova the animal is much flattened; but by-and-by it regains plumpness, and often assumes a greyish hue, apparently from the increased development of this tissue, which is exuded as a pale, salmon-coloured, semi-fluid substance on rupture of the body-wall. In *N. gracilis* (Plate XIV, fig. 3) the posterior division of the digestive system, viewed from the ventral surface, has a somewhat regularly ramified arrangement, and this is especially evident some time after spawning, when the animal has regained its condition. The colour of the region is deep green by transmitted light, whereas the œsophageal division is brownish. The pinnæ in *A. pulcher* form simple tapering papillæ under pressure. In *Nemertes carcinophila* the cavity is greatly developed, both as regards the rest of the body and its individual structures; and it also presents a firmer and more consistent aspect than usual on transverse section. The absence of the proboscidian sheath and its contents leaves the central space almost entirely at its disposal.

Microscopically, the alimentary cavity has, on the whole, less of the regular and firm glandular appearance of the same structure in the Anopla, but is more friable and cellular. Its analogy with that of the higher annelids is also borne out; for although the biliary matter is not arranged as a distinct organ exterior to the alimentary, it is incorporated therewith, and probably has a similar function. The fluid, however, which bathes the liver in the higher forms (if we suppose that inside the sheath for the proboscis to be the homologue of the former), is here separated by the muscular walls of its special tube; thus those who imagine, like Mr. Lankester, that the so-called biliary tissue in *Chætogaster* and others has some connection with the production of the corpuscles of the perivisceral fluid, find here a fact of interest. I, however, do not see the advantage or necessity of deviating from the very generally applied law, viz. that the fluid itself produces its corpuscles. The large size of the proboscis in the Enopla renders the digestive system very obscure from the dorsal aspect, and it is only when the ventral surface is upturned that a correct knowledge of its relations is obtained. No food has been found in the alimentary cavities of those examined.

7. Vascular System.

The circulatory system is composed of three great longitudinal trunks—one central and two lateral—besides the cephalic arch and anastomotic vessels. Commencing with the central trunk posteriorly (Plate XV, fig. 3, *p*) in *Amphiporus*, it is found that the vessel, which in this region is about twice the diameter of the lateral, arises from the point of junction of the last-mentioned, just within the posterior border of the worm. It travels forward beneath the proboscidian chamber in an undulated manner—as usually seen—to the region behind the ganglionic commissures, where it bifurcates (*q*), a branch passing to either side to join the lateral trunk (*r*), which bends inwards to meet it. From this point of junction also a single vascular arch (cephalic) proceeds forward into the tissues of the snout (*l*, same figure, and in Plate X, fig. 2, the latter showing the vessels in transverse section), the pillars of the arch thus meeting the lateral and anastomotic vessels of each side. From the same point of union each lateral trunk passes backwards under the nerve-cord to the tail, where it meets its fellow of the opposite side, and gives origin to the single central vessel with which the circuit commenced. The lateral trunks appear to diminish slightly posteriorly. The median vessel does not actually touch the wall of the proboscidian sheath, though transverse sections usually show a close apposition, but is situated in a layer of transparent elastic tissue intervening between this organ and the digestive tract. At the ganglionic region the vessels which go to form the cephalic arch pass below the commissures, and unite in front beneath the channel of the snout. In *N. Neesii* there are three main longitudinal trunks as in *A. lactifloreus;* but it can be observed that the lateral communicate with the central, as in *Lineus,* by transverse branches, which, however, are proportionally smaller. Whether such anastomoses occur in the pale *Amphiporinæ* is thus an open question; but they are distinct enough in this species. Two lateral trunks only could be discovered in *Nemertes carcinophila* (Plate XIV, fig. 4, *r*), which unite by a very short loop just in front of the commissures. This arch (*l*) is distinguished from the ordinary arrangement by its not extending forward into the tissues of the snout. The lateral vessels are not so clear or well defined as in *A. lactifloreus* and *Tetrastemma,* and possess internal transverse bands or partial septa in front; while the fluid circulating therein has a few clear granules, as in *N. Neesii* and others. The contractions in the lateral trunks are very vigorous, and even a minute central vessel could not have been passed over if a trace of such had existed.

The course of the circulation, so far as observed, is as follows:—Posteriorly a gentle contraction from behind forward drives the contained fluid along the great central vessel to the front, where it is forced through the anastomotic into the lateral vessels and the cephalic arch. Each lateral trunk swells with the wave, and the fluid then proceeds to the posterior end to enter the median, as before-mentioned. In addition to the stream poured into the lateral trunks, another passes into the cephalic arch by the vessel on each side, and the counter-currents must meet and commingle, returning again during the diastole of the central vessel. I have not made out any branches in the British species except in *N. Neesii;* but this is a somewhat difficult task, on account of the transparency of the vascular medium and channels.

In many species the fluid contained in these vessels is transparent and homogeneous. M. de Quatrefages, however, found corpuscles in his *Polia bembix,* Professor Keferstein small oval discs in the reddish blood of his *Borlasia splendida* (*Amphiporus spectabilis,* Quatref.), and I have seen in *N. Neesii* minute granular corpuscles, but both they and the fluid are colourless. Minute colourless globules also occur in the blood of *A. pulcher.*

The ideas of M. Dugès with regard to the circulation in these animals were rather indistinct, though he discovered certain vessels. In his figure he represents a median and no less than three lateral trunks on each side, and he further joined the ganglia to this system under the character of pellucid pouches communicating with the arcade (cephalic arch). The latter he transformed into a complex series of vessels, which need not be particularly described. He thus confounded the nervous and circulatory systems. The first point to be noticed in the descriptions of M. de Quatrefages is the statement, that the lateral trunks pass through the cephalic diaphragm—a structure which has not been seen. He is slightly in error also when he states that the median vessel lies immediately under the subcutaneous muscles. The arrangement shown in his two sections of *Borlasia angliæ* cannot apply to this group. I have not been able to verify the elaborate curves which this author gives each anastomotic division of the central vessel anteriorly, and which may be described as first forming a loop behind the ganglion, with its curve directed outwards, and a second inversely curved round the anterior border—in its passage to join the lateral, which is scarcely bent inwards at all, but occupies a space where no vessel occurs in the British forms. The mere shortening of the anastomotic will not retrieve this anatomical error. The cephalic arch is also placed otherwise than "immediatement audessous des couches sous-cutanées," as already described (Plate X, fig. 3). He mentions the presence of distinct walls to these vessels, which, however, he learned from *Borlasia angliæ*, and in this I concur (Plate X, figs. 2 and 3). The walls are highly contractile, and in the latter figure the vessels have been cut just before they complete the cephalic arch; they are observed to be surrounded by a ring of finely granular texture. M. de Quatrefages likewise states, that though fixed in front the vessels are elsewhere free, and only connected here and there to the body-wall by ligamentous bridles; and in one of his plates he figures the ova between the lateral vessels and the wall of the body. All our transverse sections show that such could hardly occur, for the vessels occupy a secure position beneath the nerve-trunks; and while the ovaries or sperm-sacs sometimes press the vessels downwards towards the ventral surface, and increase the distance between them and the nerve-trunks, they never actually intervene between the latter and the body-wall in the perfect worm. This author appears to hold similar opinions still, since he reproduces several of his former figures in his recent 'Annéles.'

Many of the older naturalists confounded the ganglia with hearts, such as Ehrenberg, Schultze, Huschke, Delle Chiaje, Dugès, Œrsted, and more recently our countrymen, Drs. Williams and Johnston. The latter mentions that the only blood-vessel he has seen is one "winding down the middle, along the surface of the alimentary canal," but he can neither trace its origin nor termination. Dr. Max Schultze, at first, seems to have mistaken the edge of the proboscidian sheath under pressure for the circulatory system, which he figures as two long straight trunks on each side of the digestive tract. The true blood-vessels he describes as pertaining to the water-vascular system, but shows neither beginning nor ending, though numerous large branches are represented as issuing from them throughout their course. In a subsequent publication he endeavoured to reconcile his early views with more modern, but fell into considerable confusion. Professor Keferstein does not distinguish with sufficient clearness the different blood-systems of the Enopla and the Anopla; and, indeed, applies the definition of the former to the latter; but so far as they go his descriptions and representations of the arrangement in this group are good. He, moreover, shows an elaborate series of minute transverse anastomosing vessels in his *Borlasia splendida*, the structure of which therefore differs from that usually exhibited by the British Enopla. M. Claparède, though his publication is more recent, is less correct than the latter author, for he figures the dorsal vessel coursing above the ganglionic commissures before giving off the anastomotic to join the lateral, and thus a somewhat stiff square is formed in the cephalic region, while the lateral vessels have to pass to the outside and front of the ganglia before meeting the anastomotic. The vessel appears also to be placed on the dorsum of the proboscis.

8. Nervous System.

a. Ganglia.

In the living animal two carmine, pinkish, or reddish colorations are observed on the snout, some distance behind the tip: these mark the position of the cephalic ganglia or nervous centres in most of the Enopla. As previously mentioned, not a few authors, misled by their colour, pronounced them to be hearts. Under a lens they are somewhat pyriform, and each consists of two divisions—a superior, shaped somewhat like an almond, and an inferior, continuous with the great nerve-trunks. The superior lobe is connected with its fellow of the opposite side by the *large* or *superior commissure* (Plate XI, fig. 1, *f*), which passes over the proboscis. In ordinary circumstances this commissure is less than half as broad as the inferior, but it is considerably longer. It forms a simple ribbon of transverse fibres, some of which, after diverging, turn slightly forward, but the majority pass obliquely backwards to the pale central part of the lobe. The only remark made by M. de Quatrefages with regard to its physiology is that it removes the somewhat surprising condition of having a brain composed of two lateral masses, and only one commissure. This band, however, seems of more interest, since during the enormous distension which takes place in the extrusion of the proboscis, it is the superior commissure which is stretched to an extreme degree of tenuity. The organ, passing through a complete ring of nervous texture, must force this outwards in every direction during extrusion, and especially superiorly, the inferior commissure, indeed, being only slightly affected. Nearly half the circumference of the proboscis projects above the level of the ganglion (Plate X, fig. 8), and the superior commissure must be correspondingly elongated; hence we have an interesting example of the elasticity of a nervous band. The inferior commissure consists of a thick mass of fibres, the majority of which sweep backwards to form the lateral nerve-trunks; thus it becomes a commissure between these cords. A few of the anterior fibres are connected with the central region of the former division of the ganglion.

Carefully made transverse sections show how incomplete is the impression conveyed by the examination of the parts in a compressed though living animal. Instead of forming a flattened organ, whose greatest diameter is across the plane of the body, each ganglion has its long diameter nearly perpendicular to the latter (Plate X, fig. 8, and Plate XI, fig. 1). The nerve-cells do not appear to be confined to the superior portion, but occur in the inferior also (Plate XV, fig. 4), on each side of the origin of the great nerve-trunks. In the fresh specimen the sheath of the ganglion is moderately resistant; for under pressure the cells from the interior do not pass readily through, but escape by travelling along a portion of the great lateral trunk, and out at its torn end, or by other branches, such as the superior and inferior commissures and the anterior nerves, or through accidental punctures. The nerve-cells have a yellowish tinge, are minutely granular (Plate XV, fig. 6), and rapidly alter their appearance after escape into the water. Many contain a large reddish granule or granules, to which the colour of the organ is partly due; but I cannot say all the numerous pigment-granules are so located, though they may have been. In the fresh, as well as in the prepared condition (Plate X, fig. 8), the entire ganglion is dotted with minute pigment-specks and granules, which are also continued along the great nerve-trunk for a considerable distance. The superior commissure is faintly tinged with colouring matter, the inferior more so; both are paler than the masses of the ganglia. The hue of the ganglia is not destroyed by sulphuric ether, but is rendered pale by acetic acid. The distinction between the superior and inferior lobes is sometimes clearly shown in oblique sections, which give, on the same side, a portion of the superior lobe, as well as the origin of the nerve-trunk (Plate XV, fig. 1).

In the elongated species, such as *N. gracilis* (Plate V, fig. 4) and *N. Neesii* (Plate XV, fig. 5), the ganglia are not correspondingly lengthened, but are somewhat rounded. They are also rounded in *A. pulcher* (Plate XV, fig. 2) and *A. spectabilis*. In *Tetrastemma melanocephala* (Plate XIV, fig. 2) the arrangement is very similar to that in *A. lactifloreus*. In *T. flavida*, however, the inferior commissure is rather shorter and broader (Plate XIV, fig. 14), and the lobes more elongated. This is also the case in *Prosorhochmus*.

The ganglia, according to M. de Quatrefages, are surrounded by a sheath forming a sort of dura mater, at least in a large *Borlasia* (*angliæ*?), for he could see none in the smaller species. In the Enopla the muscular and other structures of the head form a somewhat condensed capsule round the ganglia, independently of the delicate sheath proper of the nervous matter. The longitudinal fibres of the former, indeed, constitute powerful bands between the ganglia and the inner muscular layer of the body-wall. This author also mentions the occurrence of ventricles in the interior of the ganglia, and figures them in *Polia berea;* such have not appeared in any British form, though under pressure collections of fatty matter closely resemble his drawing. I have never been able to see so many branches proceeding from the anterior borders of the ganglia (as he shows) to the eyes, cephalic fossæ, " mouth," and other tissues, in addition to the great trunks and other branches posteriorly. The arrangement in the British Enopla (Plate XV, fig. 4) is as follows:—Three very distinct branches occur on each side of the superior lobe anteriorly (two about equal in size); a third, much smaller, to the outer side; and, lastly, traces of a fourth branch. The outline of the ganglion, throughout the rest of its extent, is quite smooth. Various branches from these trunks proceed in the direction of the eyes; but the nature of the cephalic tissues renders it very difficult to trace such an object as a pale nerve-twig with certainty. Dr. Max Schultze gives a tolerably correct view of the ganglia and nerves in *Tetrastemma obscurum;* no branches, however, occur on the trunks in his figure. This author, in a subsequent publication, founded one of the chief distinctions of his *Enopla* and *Anopla* on the structure of the ganglia. E. Graeffe, again, in his remarks on a *Tetrastemma* from Nice, states that he found a small cluster of otolite-capsules between the eyes, each capsule containing a crowd of minute otolites. Professor Keferstein figures only two branches proceeding from the anterior part of each superior lobe to the eyes in his *Borlasia splendida* (*A. spectabilis*, De Quatrefages); but he represents a kind of meshwork, formed by three or four trunks, between the side of the lobe and the cephalic sac, and a pair of nerves from the inferior commissure to the proboscis. I have not made out the latter in the British specimens. He also describes the occurrence of an otolite or two in the middle of the ganglion of a young *Œrstedia pallida.* The latter condition has been delineated by M. Claparède, the otolite-capsule in each case being situated in the centre of the organ, and consisting of a cell-wall containing three spherical granules. The same author figures the proboscis passing beneath the great or inferior nervous commissure, with the central blood-vessel above both.

b. Great Lateral Nerve-Trunks.

These (*n*) spring from the inferior lobes of the cephalic ganglia, pass backwards within the inner (longitudinal) muscular layer of the body-wall to the posterior end of the worm, where they terminate near the tip. They are surrounded by a coat of the usual delicate fibrous stroma of the parts, and are often tinted of a reddish hue at their commencement. The branches given off by these trunks are generally pale and indistinct, but by the use of dilute acetic acid in *A. lactifloreus*, and in others without such aid, they can be satisfactorily observed. They are easily seen, for instance, in *A. pulcher*, the reddish colour which tinges them at their commencement shining through the translucent integuments. An elaborate plexus of branches from the lateral trunks has also been noticed in this species (Plate XVI, fig. 3). In the same form, and in *N. Neesii*, there remains, even after continued pressure, a peculiar narrowing of the great trunks immediately behind the ganglia, which, if not an original condition, may be due either to comparative immunity from pressure, or a tougher investment. In transverse section the nerves present a delicately granular appearance, from the ends of the fibres. No one who has seized on such specimens as *N. gracilis* in semi-contraction (though unwrinkled), and drawn them out to treble the length and upwards, can doubt the peculiar elasticity pertaining to the lateral nerves in these animals. According to Dugès, indeed, Darwin thought nervous substance was contractile.

The nerve-trunks are placed by M. de Quatrefages "between the external longitudinal and internal transverse muscular fibres" of the body-wall; a position which may in some respects apply to the Anopla, but is inapplicable to the present group. Frey and Leuckart mention that the lateral nerves lie inside the muscular coats; but while indicating the different arrangements of the "brain" in *Tetrastemma* and *Borlasia,* they do not explain the distinction in regard to the position of the nerve-trunks in these genera.

9. *Eye-Specks.*

The eye-specks are situated beneath the superficial muscular coat; thus, in many spirit-preparations none are visible until the dermal layers are removed. In most examples they consist of simple masses of black pigment. So far as has been seen, only four British Enopla, viz., *A. pulcher*, *A. spectabilis,* the Zetlandic variety of *Tetrastemma candida*, and *Prosorhochmus Claparedii,* show a special arrangement in their eye-specks, and even in those it is of a very elementary character. In the former the pigment in each eye-speck is grouped into a globular mass with a smooth outline, and in the living animal under examination there is frequently a clear patch in the centre (Plate XIV, fig. 15); but, though the mass retains its well-defined outline after the removal of the pigment by caustic potash, no capsule could be made out as a separate structure. The brownish Zetlandic variety of *Tetrastemma candida,* again, has the anterior pair of eyes considerably larger than the posterior, the former, moreover, often presenting a crescentic margin in front. The pigment-grains are arranged in the same manner in both, but the outline of the posterior pair is more irregular and less finished than that of the anterior. Each of the latter has a somewhat pale space in front of the crescentic margin, so that the eye appears to be furnished with a capsule or lens, but I have not been able to demonstrate either, and conclude that it is a pallor due to the greater translucency of the tissues in front of or over the pigment. Such, doubtless, may indicate a step in the formation of a lens. A clear globule has been seen in connection with the anterior eyes of *Prosorhochmus Claparedii,* but it may have been a simple cutaneous structure.

In *N. gracilis* and others, a few of the eye-specks are frequently connected together by bridges of the pigmentary substance. Though a pale portion is sometimes seen in the specks of the former, there is no evident capsule or lens (Plate XIV, fig. 2). The large black pigment-patch on the snout of *Tetrastemma melanocephala* often includes the first pair of eyes; while in *T. vermicula* the eyes of each side are connected by a longitudinal band of dark pigment, which frequently becomes crescentic in contraction. Mediterranean *Tetrastemmæ* with "lenses" to the eye-specks have been noticed by Delle Chiaje, Kölliker, Graeffe, and A. F. Marion.[1] I have found the specks disappear from adult specimens of *Prosorhochmus Claparedii,* after a year's confinement.

[1] 'Ann. Nat. Hist.,' 4th ser., vol. iv, p. 136.

10. *Cephalic Furrows and Sacs.*

Midway between the tip of the snout and the anterior border of the ganglion in *A. lactifloreus*, a furrow runs inwards and slightly forward on the dorsum, ceasing, however, before the central line is reached; and on the ventral surface a similar though shorter furrow exists, the two meeting in a dimple, furnished with longer cilia, on the side (where the cilia are more active and powerful than usual), which depression leads into the cephalic sac. A short distance behind the ganglia two other superficial furrows occur, each slanting backwards and inwards to meet its fellow of the opposite side in the middle line. These furrows are also continued inferiorly, but with a slightly different direction, so that they meet under the ganglia. The two sets of furrows are very distinctly marked in a flattened head by lateral notches. From the dimple mentioned in connection with each anterior furrow, a thick-walled ciliated duct leads into a considerable ovoid, pyriform, or almond-shaped glandular mass, which lies in front of and rather exterior to the ganglion of the side (Plate XV, fig. 4, *m*), and from what is seen in translucent species, such as *Tetrastemma vermicula*, it would appear to end in a *cul-de-sac;* the walls, moreover, under pressure are marked by transverse rugæ. Towards its first part the duct is surrounded by a minutely granular glandular structure, which usually has a somewhat triangular figure. Several glandular masses lie behind, one to the outer, and another to the inner side in this position. The glandular substance around and behind the posterior part of the ciliated external duct contains numerous granules and finely granular cells. From the posterior end of the outer mass in such a view, a structure having the aspect of a pale duct passes obliquely towards the superior lobe of the ganglion, crossing this for some distance in a direction inwards and backwards. Traces of a cavity are apparent at its commencement, and, besides, it is distinguished from the adjoining nerve-trunks under pressure by not being continuous with the ganglion at its edge. In transverse sections of the snout, each sac occupies a position outside the cephalic blood-vessel, and somewhat above it (Plate X, fig. 3, *m*), and has a special space in the muscular stroma of the head. In large specimens the sacs contain many reddish pigment-grains, and occasionally a large cell filled with coarse granules. Behind the foregoing glandular apparatus lie the coiled ciliated ducts (*m'*), which are sometimes pale and irregularly bulged from included fluid, or else collapsed and minutely granular in aspect. In some specimens of *A. lactifloreus* the commencement of the duct is tinged of a faint reddish hue. There seems to be no ground for the supposition that the sacs are connected with other organs. In *T. melanocephala* (Plate XIV, fig. 2) they are less dilated than in *A. lactifloreus*. The coils of the ciliated duct in *N. gracilis* are most elaborate, and can be traced a long distance backwards by the side of the nerve-trunk. In *N. Neesii* the external apertures are not so evident as in *A. lactifloreus* and *Tetrastemma*, because the furrows are less distinct when viewed as transparent objects. They are best seen when the ventral surface is upturned, and occur in the angle of the furrow some distance from the margin of the head in this position (Plate XV, fig. 5). The ciliated pit leading inwards is short. Like other parts of *A. pulcher*, there is a considerable deviation from the typical form in the shape and position of these sacs, as well as in regard to the furrows. This species (Plate XIV, fig. 11) has also numerous short longitudinal or accessory furrows on the front of the ventral grooves, and thus is allied to *A. spectabilis*. Instead of lying in front of the ganglia (in the ordinary position under examination), the sacs are situated laterally and posteriorly, forming somewhat elongated pyriform organs, which adapt themselves to the curves of the ganglia (Plate XV, fig. 2). Each sac is filled with rounded granular cells, reddish pigment- and other granules, has a ciliated duct opening anteriorly at the constriction or lateral dimple of the head just in front of the ganglia, and posteriorly ends in a ciliated tube which by-and-by bifurcates, each of the trunks giving off various branches. The latter are furnished with numerous granular cells, apparently imbedded in the wall of the tubes, so that in contraction they have a cellulo-granular appearance, somewhat similar to the "segmental" tubes of the Oligochæta. There are also in this species a number of branched vessels of small calibre behind the ganglia, apparently in connection with the circulatory system. In the snout of the same worm is a series of well-marked glandular organs in front of the nerve-centres, viz., a lobulated mass (*g*) in the middle line, connected with a lateral (*gi*) on each side of the blood-vessel. These glands agree in structure, containing granular cells, pigment- and other granules. A process (duct?) passed from the posterior end of the external lobule towards the cephalic sac. Traces of similar glandular masses were seen in other species (*e.g. A. lactifloreus*) near the middle line of the snout, behind the cephalic sacs, and elsewhere. In *A. spectabilis* the cephalic sacs appear to be allied to those in the foregoing, and possess an ovoid outline with a process posteriorly. In my softened specimen they were found behind the ganglia, and were filled with granular cells and granules. The cephalic furrows in this species have a series of accessory grooves (Plate III, fig. 7) much more developed than those in *A. pulcher*. In *Tetrastemma* the sacs coincide in structure with those of *A. lactifloreus*, and in translucent specimens, such as *T. flavida*, the ciliated posterior ducts are easily traced. Those of *T. Robertianæ* resemble the same organs in *T. candida*.

The slight furrows just described on the head in this group have been noticed by few investigators, and only Professor Keferstein and M. Claparède mention the occurrence of the sacs; the former using the term *Seitenorgane* for their signification, but his notice is very brief. He figures and describes his *B. splendida* (*A. spectabilis*) as furnished with sacs at the side of the ganglia, but without the ciliated ducts posteriorly; while in *B. mandilla* the latter reach no further back than the ganglia. M. Claparède, again, shows on each side of the eyes in the young of *Prosorhochmus Claparedii* a blind sac, apparently unconnected with the ciliated pits above-mentioned; moreover, in the drawing of the adult animal (fig. 10) there is on each side a ciliated duct, but no sac. M. de Quatrefages only noticed traces of these structures in the Enopla; for he describes bridles or bands stretching outwards to the "fossettes céphaliques." In his *Polia bembix* he represents a large nerve passing from the anterior part of each lateral column, not far behind the ganglion, and which, after a course directed obliquely forward, ends in a dilated granular condition at the cephalic fossa. A similar arrangement occurred in *P. humilis*; but in this instance the nerve arose from the superior lobe of the ganglion, passed obliquely forward and outwards, and ended in several branches at the fossa. In *Cerebratulus crassus* and *Nemertes peronea*, again, he figures the nerve springing from the posterior part of the superior lobe. He does not seem surprised that the nerve-trunks to these fossæ should come from sites so diverse as the front of the superior lobe and the lateral trunk. The disposition of an important nerve in species of the same genus, or even in allied genera, is seldom so varied. The structure seems to have been misinterpreted in the Enopla, the sac overlooked, and the process or duct, which sometimes crosses to the origin of the great nerve-trunk and ganglion of its side, assumed to be a nerve-branch. M. van Beneden, though he noticed the sac in *Lineus*, does not mention more than "fossettes céphaliques" in this group.

11. Generative System.

In the majority of the Enopla the sexes are separate, the only known exceptions being the *Borlasia hermaphroditica* of Keferstein, and the *Borlasia Kefersteinii* of Marion. The generative products are developed between the inner muscular layer of each lateral region of the body and the glandular digestive cavity, and enclosed in special spaces (Plate XVI, fig. 13) formed by transparent membranous sacs (*e*), which are connected with the inner muscular layer of the body-wall (Plate XVI, fig. 2, *f*). The contents are evacuated by pores above the lateral nerve-trunks, which (pores) are very distinct immediately after the issue of the ova or spermatozoa.

a. Male Organs.

The sperm-sacs in the male (Plate XVI, fig. 5, *e*) generally present a pyriform or flask-shaped aspect, especially in the early stages, being attached to the body-wall by a narrow tubular neck, which at the proper period doubtless gives transit to the contents of the sac. In the early condition the latter is minutely granular, then cellulo-granular; and in the mature state it has a finely fibrous or streaked appearance from the spermatozoa.[1] Sometimes both granules (Plate XIV, fig. 17) and spermatozoa occur in the same sac, and then the former are often observed to be somewhat regularly arranged (Plate XIV, fig. 16). The spermatozoa in *A. lactifloreus* (Plate XIV, fig. 18) have a slight curve of the body, which gently widens from the tip and ends in a perceptibly larger rounded knob, to which the long tail is attached. The mature males are easily distinguished from the females by their whitish or pinkish aspect, and their bodies are less distended. The spermatozoa of *N. gracilis* (Plate XVII, fig. 8) are most active wriggling structures, of a more slender shape than those of *A. lactifloreus* or *Tetrastemma* (Plate XVI, fig. 7), appearing under a power of 1000 diameters as simple rods, slightly larger towards the end from which the elongated and very fine tail proceeds.[2] The sperm-sacs are very numerous in *N. carcinophila*; but the tenuity of the spermatozoa (Plate XVII, fig. 9) renders their exact structure somewhat obscure. The body of the spermatozoon is elongated, gently curved, and slightly thickened at the end to which the filament is fixed. It is very common, moreover, to observe one or more minute clear globules attached to the spermatozoon, so that the structure seems to have a tail at both ends, or a flattened head. These appearances have misled even so experienced an observer as M. van Beneden, who figures the organs as possessed of a somewhat globular body, with a filament at each pole. But, independently of the strange exception which such a condition would make in Nemertean physiology, the frequent occurrence of more

[1] This peculiar striation resulting from the arrangement of the spermatozoa has been seen in other groups of the animal kingdom, *vide* Allman, 'Gymnoblastic or Tubularian Hydroids,' p. 65, f. 31, C, and Bütschli, 'Zeitsch. w. Zool.,' Bd. xxi, 4.

[2] Prof. Huxley finds the filament also attached to the broader end in the Hydrozoa.

than one globule on these thread-like organisms, and the comparative steadiness of the body of the spermatozoon, contrasted with the lashing of the tail, might have raised a doubt in the mind of the distinguished author. The spermatozoa in *Tetrastemma vermicula* (Plate XVI, fig. 6), though minute, are amongst the most active of the group. They are slender at one end, and gently dilate towards the opposite, which is furnished with a very long tail. Just in front of the posterior extremity is in certain views a somewhat abrupt swelling of the body, as if from an adherent globule, but none were observed without the enlargement. The spermatozoa of *A. pulcher* (Plate XVII, fig. 10) have bodies more or less dilated at one end, and tapered towards the attachment of the tail, but in other views they are spindle-shaped. They are very minute, even more so in the specimens examined than in the smaller Enopla. In *Tetrastemma Robertianæ* these bodies present the form of slender rods, having a small globule attached near the end (Plate XVII, fig. 26) furnished with the tail. After remaining in the water a short time, the form of the spermatozoon completely changes, the rod or body becoming fused into the globule, which enlarges accordingly, and assumes the form of a granular cell with the filiform tail still adherent. A granular aspect was likewise observed in many of the newly voided spermatozoa of *Amphiporus bioculatus,* the bodies in this case being ovoid and somewhat pointed at the ends (Plate XVII, fig. 25).

b. Female Organs.

In the matured females of *Amphiporus lactifloreus* the ova extend from the œsophagus almost to the tip of the tail, each ovary containing from one to seven ova, which, when fully developed, are seen with the naked eye through the attenuated parietes of the body. They attain a comparatively large size before deposition, and are not much less in small specimens, though few in number. The female in the ripe state has a greyish-white appearance, with the dorsal tube for the proboscis extending nearly from end to end, though its diameter is diminished posteriorly from the encroachments of the ovaries. In the smaller species the arrangement of the system can readily be observed in the living animal as a transparent preparation (Plate XVI, fig. 13). The outer hyaline investment of the egg is generally corrugated before extrusion.

M. Dugès correctly located the generative products in pyriform pouches along the sides of the body, and thought they resembled the ovaries of *Tænia,* which open exteriorly in every segment. He observed three or four vesicles containing a pulpy substance in *Prostoma lumbricoides,* so that in all probability his specimen was a female. M. de Quatrefages, Frey and Leuckart, and Dr. Johnston, again, describe the ova as occurring in a free condition between the body-wall and the alimentary cavity. The former (M. de Quatrefages) confounds the digestive with the generative system, indeed, gives a tolerable figure of a cell from the wall of the alimentary cavity as one of the true stages in the growth of the spermatozoa; and again refers ('Voyage en Sicilie,' Plate XXII, fig. 2) to the glandular wall of the said cavity as representing generative cæca. The spermatozoa, therefore, which he shows, had either been discharged externally, or procured from a specimen in such a condition as to leave no room for doubt. His figure of the male elements from *N. balmea* is incorrect, for the body of each is too short and thick. He considers that it is only after the granular corpuscles fall out of the cæca into the lateral cavities that they assume their special characteristics as sperm-cells. He thus fails to make out the correct anatomy of the parts and the physiology of the process. Dr. Williams states that the "segmental organs" in Lineus, Borlasia, and Nemertes correspond in number with the transverse divisions of his great "alimentary cæcum" (digestive cavity), and that there is only one British species (*Polia quadrioculata*) in which it is possible to demonstrate the segmental organs *in sitû* as transparent objects. It is almost unnecessary to contradict the last statement, since small specimens of most Nemerteans are more or less translucent. This author also maintains that the group agrees in the structure of its generative organs with the type of the lateral ovarian pouches of the Hirudinei, differing from the latter, however, in having the sexes separate. Van Beneden and Keferstein give a correct account of the position of the ovaries and sperm-sacs in the species examined by them; but the term "biliary cæca" used by the former is objectionable, as tending to confound the generative and digestive systems. M. de Quatrefages imagined that the ova were extruded by a temporary aperture in the Enopla, and pointed out that Œrsted and Dugès were wrong in averring that they escaped through the walls of the body. Œrsted's observation, however, is correct, as subsequently proved by Van Beneden and Keferstein. Frey and Leuckart erroneously conjectured that the ripe ova were shed from the posterior end of the body, "as in Arenicola."

12. *Phenomena of the Deposition of Ova and Spermatozoa.*

The ova and spermatozoa in *A. lactifloreus* would seem to attain full development in February, March, and April; but the breeding season of other examples of the Enopla ranges from the latter month to November. Specimens of *A. lactifloreus,* which had been in confinement seven months, deposited their ova about the middle of February, and wild examples a little later. The actual number of ova was not counted; but in one instance those from a single female covered a circular space more than half an inch in diameter. In several species, *e.g.* *N. gracilis,* *N. Neesii,* and *A. spectabilis,* the number of ova is immense. Occasionally, in a crowded vessel, the ova of *A. lactifloreus* are found above the water-line, adhering to the vessel in an irregular mass; but they are held together only by accidental mucus, and easily fall asunder. There is, therefore, a characteristic difference in regard to the deposition of the ova between this group and the Anopla; for in the latter they have a totally different shape, and a special investment of tough mucus. The only exception, so far as I have yet found, in regard to the deposition of the ova in a free condition, occurs in the aberrant *Nemertes carcinophila.* The body of the worm considerably diminishes after spawning, and assumes a flattened form, especially in large examples. That impregnation of the ova (in *A. lactifloreus*) takes place only after deposition is proved by segregating a female ready to spawn, for then it is found that no further change ensues in the egg. Hence the large size of the male organs, as in fishes and other animals that shed their secretion in the surrounding water.

When fully developed, the mode of depositing the ova and spermatozoa may be illustrated by the following account:—Two specimens, male and female, of *N. gracilis* were taken from a deep vessel, and subjected to examination in a large glass trough. A very few minutes after the male had been placed on the bottom of the cell tiny jets or jet-like wreaths of sperm-fluid issued from the sides of the body, rather past the middle, and gradually increased in number, both in front and behind. The animal was soon enveloped in a wavy cloud of the milky substance, whose borders were slowly commingling with the surrounding water, while the numerous coiling jets, like so many miniature wreaths of white smoke from the sides of the worm, were constantly adding to the central mass. This operation lasted only a few minutes, and thereafter the animal moved about the vessel. The female specimen now protruded her snout from the sand and mucus in which she was coiled, and, passing to the side of the cell, deposited in a few minutes a group of ova, about three inches distant from the white edges of the sperm-cloud, retiring again under the mass of sand and mucus. The change of water probably caused the male to eject the matured spermatozoa, and some sympathetic influence, it may be the diffusion of the latter, induced the female at once to evacuate her generative organs, so as to afford the ova the benefit of the male element. A very few ova were found on examination to remain in the body of the female, and they differed in no respect from those deposited in the vessel. The apertures by which the respective elements passed out in these specimens were readily observed as pale specks, each furnished with a central opening, round which for the moment the cilia were well seen. These openings, as in *Lineus*, occur a little above the lateral nerve-trunk on each side, and even in specimens of *A. lactifloreus* not fully ripened, pressure forces the contents of the generative sacs in the same direction, although no aperture is visible.

13. Development.

The unimpregnated ova in *A. lactifloreus* (Plate XVI, fig. 8) are pure white, and measure $\frac{1}{72}$nd of an inch in diameter, the pale spot just before deposition being about $\frac{1}{225}$th of an inch. The ovum has two coats—an external hyaline investment (*a*), which becomes considerably firmer after extrusion, and an inner membranous sheath (*b*), of greater delicacy, enveloping the vitellus (*c*). With the exception of the pale spot the ovum is uniformly granular, the granules on gaining freedom showing active molecular motion in the surrounding water. At a particular point is a very distinct process (micropyle ?) (*d*), as if from the remains of a tube that led through the outer coat. A few hours after deposition and impregnation the pale spot disappears, the yolk divides into two masses (Plate XVI, fig. 9), and shortly afterwards into four (fig. 10). On the second day almost all the ova are in the mulberry-stage (fig. 11). In seven or eight days the embryo revolves within the capsule by aid of its cilia, and the majority are extruded from the twelfth to the fourteenth day. The young animal is furnished with two eyes before bursting the egg (Plate XVI, fig. 12), and the coarse granular matter and globules of the digestive tract are apparent. In this condition the wall of the ovum is readily ruptured, and no sooner do the young get over their labours of extrusion than they glide rapidly off, head first, in a manner that shows no training is necessary to enable them to progress. They somewhat resemble the ciliated planules of the Hydroid zoophytes and the young of many of the higher annelids. Probably the action of the cilia may have some influence in determining their course. In these young animals, which are just visible to the naked eye as minute specks, the proboscis is marked by a pale space (Plate XVII, fig. 1), that has on each side a dense mass of the granules of the digestive canal. Outside the latter are two pale stripes, broader in front, caused by the nervous ganglia and trunks. Two longer cilia mark the posterior end. A further stage of development (after an interval of about eight days) is shown in Plate XVII, fig. 2, under somewhat less pressure. There are now four eyes, the anterior pair being the larger. Occasionally a few have an additional pigment-speck or two near the posterior eyes. The latter are further apart than the anterior, differing in this respect from those of the young *Tetrastemma,* in which the eyes are equidistant in both pairs. The ganglia (*h*) are large, pale, distinctly outlined, connected by the two commissures, and give off the lateral nerves (*n*), which approach each other very closely at the posterior end. The œsophageal sac (*j*) behind the ganglia is well defined; and two pale streaks mark the cephalic sacs (*m*). The proboscis has its anterior opening, and the first region (*a*) its glands, the posterior border being marked by a transverse line (*b*), after which follows an indistinct stylet-region and reservoir. No stylets are visible until much crushed, and then in one specimen two slender spikes, probably from the marginal sacs, were seen. The posterior region of the proboscis bends forward, and becomes lost at *c*. Shortly after the marginal stylet-pouches in some become very evident, opening by a short and wide tube into the floor of the anterior chamber, and either containing granules or small stylets, while the central apparatus is unarmed (Plate XIII, fig. 12). The specimen had really only granules in its sacs; but to save multiplication of figures one was deleted, and filled in with a correct drawing of stylets from another example. There is no trace of a central stylet, but the basal apparatus has coarse granules, which move with the muscular investment around them, for at this time the latter exhibits distinct contractions. The muscular space (*ε*) behind the floor of the anterior chamber shows indications of an inner and special lining, which forms a transverse boundary in front. The basal structure is less defined than in the adult, but, as development advances, the form of the "awl-handle" becomes more characteristic. The marginal stylet-sacs a few days afterwards are generally furnished with stylets, but these organs are not so sharp and smoothly finished as in older examples. When the central stylet appears, the granules of the basal apparatus have a more definite shape than represented in the figure. An outline of the two kinds of stylets is given in Plate XII, fig. 5, from the same specimen, and the disproportion between them is evident, thus confirming the previous statement, that each apparatus furnishes its own organs. The central stylet (*a*) is generally more slender and acute, as well as longer than the marginal (*b*), the head of the latter being more globular than in the adult. As the specimen increases in age, the disproportion between the stylets lessens—one or more of the marginal being equal to the central in size. The long posterior chamber of the proboscis now contains the peculiar fluid with moving granules, and the reservoir sometimes contracts with force, so as to propel the granules, and even the glandular lining of the cavity itself, forward to the front of the basal apparatus. The superficial granular glands of the stylet-region are also well developed.

Some weeks afterwards (and there is no difficulty in preserving them for this period, even without a change of water) four eyes are observed in the majority. The head of the worm is distinctly marked in progression, and the cuticle richly ciliated, a few longer cilia occurring at the snout and tail. The cilia are also very active in the cephalic pits, the openings in which are circular; and there is, moreover, a slight constriction at this point between the two pairs of eyes. The dermal tissues are well seen, and the ganglia still remain relatively large. Every structure pertaining to the proboscis now shows considerable advancement; and it may be noted that the posterior glandular organ is wider and shorter in proportion than in the adult. In each marginal stylet-sac (Plate XIII, fig. 13) there are at least three well-developed stylets—the heads of which still appear somewhat more globular than in the perfect animal, besides a headless fragment or two, and a few clear granules. The normal position of these organs in the marginal pouches seems to be transverse. The stylet on the central apparatus is completely formed, and likewise has a somewhat globular head. The muscular cavity (ϵ) is kept in constant jerking contractions under pressure, while the posterior part (θ) is quite still. The other structures, such as the cells of the digestive cavity, have made corresponding advancement, but no blood-vessels are apparent. It may be mentioned, in passing, that the cuticular tissues of these domesticated examples become less transparent than in the wild forms brought from the rocks, and the examination of the internal organs is consequently interfered with. In these young animals also (under pressure) the proboscis generally escapes by rupture at the posterior end, as in *Tetrastemma dorsalis*, probably by passing through the anus. In the adult protrusion rarely occurs posteriorly, but almost invariably anteriorly.

The ova of *N. gracilis* (Plate XVI, fig. 15) are much smaller than those of *A. lactifloreus*, and when first deposited slightly adhere together, so that they may be pushed *en masse*, but they afterwards lie flatly on the bottom of the vessel. Each likewise possesses two coats. The vitellus is dull yellow. Though there is no doubt the spermatozoa in this, as in other species, rapidly diffuse themselves throughout a large quantity of water, yet they were applied directly to the ova by means of a pipette. In about four hours many were adhering to the exterior of the hyaline coat, others were within it, while a few seemed to have penetrated both capsules (Plate XVI, fig. 16). At the sixth hour cleavage has proceeded much further, so that many present the usual mulberry-aspect. In *A. pulcher* the ova *in sitû* have a beautiful rose-red colour, with a clear spot in the centre. Each ovisac in the middle of the body contains from twelve to twenty ova, therefore it is unlikely that this is a viviparous species, unless a single ovum only happens to be detained in an ovisac here and there, impregnated and developed. Numerous specimens of this form have been perseveringly forwarded from the deep water of St. Andrews Bay for several seasons, since I was anxious to watch the development; but, unfortunately, the great delicacy of the females at the time of deposition has hitherto frustrated my efforts. Towards the end of June and beginning of July (at which period the ova are matured) the females frequently break themselves in pieces, or discharge their ova in a mass only to perish in their midst. The males, although their spermatozoa are fully developed, do not appear to fecundate the female products. After deposition the ova have a delicate yellowish-red hue, with a pale, translucent spot, and a somewhat bulky hyaline investment. Like the coloured ova of many animals, they are blanched by death. The ova (Plate XVI, fig. 17) are matured in *Nemertes Neesii* from the end of March till June, and some even are loaded with ova in November. On deposition they are simply spread out on the bottom of the vessel, and unconnected by mucus. The yellowish yolk is surrounded by a fine translucent coat more than twice its diameter. The same delicacy in the ripe females and the non-fecundation of the ova by the males have prevented the study of their development. In *Amphiporus spectabilis* the ova, which were deposited by a captive specimen in November, had a white yolk and a loose transparent investment, but as they had perished before they were noticed the colour is uncertain.

The young of *Tetrastemma dorsalis* are found in swarms beside the adults in the beginning of July and September. They are so mobile that the body scarce retains the same shape for two consecutive seconds, though approaching a cylindrical form in general, especially when swimming (Plate XVII, fig. 3). The surface is coated with long cilia, by aid of which they are piloted through the water like infusorial animalcules; while, in addition, they are furnished with a single long tuft anteriorly, as observed in *Nemertes carcinophila.* The cutaneous textures are not distinguishable in the slightly compressed animal (Plate XVII, fig. 4) as separate layers, and the entire body has a cellular appearance, probably from the individual elements of the digestive cavity and the cuticular cells and areolæ. No eyes are visible. About a week afterwards considerable progress has been made in size (Plate XVII, fig. 5), but the cilia have become shorter in proportion to the bulk of the animal; and though the anterior and posterior ends show a few conspicuous cilia, the long tuft is absent. The proboscis is situated far back and scarcely recognizable. There are now four eyes. In another week the stylet-region of the proboscis is nearly complete, the marginal often appearing before the central stylets (Plate XVII, fig. 6). The usual mode by which the proboscis escapes under pressure is by rupture per anum (Plate XI, fig. 17), an accident to which the structure is peculiarly liable, on account of its posterior position. Thus there is a slight divergence in the development of this species, the young of which move freely as eyeless organisms, provided with a long ciliary tuft; while in *A. lactifloreus* two well-marked eyes appear in the young *in ovo.* The ganglia and lateral nerves, the œsophagus and other tissues are now distinctly outlined. The large size of the proboscis, as compared with the digestive tract, is also conspicuous in this form. In *T. vermicula* the ova are well advanced in April, and are generally deposited in May. They are surrounded by a loose hyaline capsule (Plate XVI, fig. 14), and the yolk is white.

Numerous specimens of *Nemertes carcinophila* were sent from St. Andrews in April, full of ova, and their development could easily be followed out. The newly deposited eggs (Plate XVI, fig. 19) are somewhat ovoid, about $\frac{1}{250}$th of an inch in their long and $\frac{1}{320}$th to $\frac{1}{350}$th in their short diameter, and appear to possess only a single investment. They are not simply enclosed in a sheath, as M. van Beneden says, but the animal, during deposition, envelopes them and its body in a tough hyaline mucus, afterwards withdrawing itself therefrom, as in *Lineus,* so that the whole forms a tunnel, with the ova in its walls. The spiral appearance of some of the masses is due to the coiled condition of the animal during deposition. After extrusion the ova pass through the usual stages, and the embryo in each is sometimes ciliated on the tenth day (Plate XVI, fig. 20), although entire dependence cannot be placed on this date, since development occurs within as well as without the body of the parent. In a short time the young are extruded either with a pair of eye-specks, or without them, and furnished with a very long anterior, and a shorter posterior tuft or whip of cilia (Plate XVII, fig. 7). Moreover, numerous adult specimens are found towards the end of April to contain ova with ciliated young, showing that impregnation, as may easily be understood, can take place through the genital pores. In many ova the embryo has two reddish eyes, and some are extruded from the sacs of the parent in a free state, so that they sail about actively as ciliated pyriform bodies. The motion of the cilia in the œsophageal region in those with eyes is very distinct; indeed, after the other and apparently more delicate tissues of the animal have become disintegrated, this region is left in full action—dissected out, as it were, by rapid decay. The somewhat globular œsophageal region has probably been mistaken by M. van Beneden for a mouth. The same author fell into the error of supposing that a form having a smooth outline was developed within its progenitor with the long ciliary tuft, the former representing the *scolex,* and the latter the *proglottis;* in short, as he says, a case of digenesis, and not a metamorphosis. But his drawing represents the so-called *proglottis* furnished with two eyes exactly in the same manner as the *scolex*, yet he neither mentions having seen the one form inside the other nor figures this interesting condition. No such mode of development has ever been seen by me, either in the case of those ova deposited in the unimpregnated condition or in those developed within the body of the parent; but the same gradual changes ensue in the young of this animal as in *Tetrastemma*, and, as will afterwards be seen, also in *Cephalothrix*.

Many of the parents with developing young in their interior are feeble, and almost in a decaying condition inside the sheaths, so that the inert bodies seem but the nidi for the growth of their progeny, each of which, provided with two boldly marked eyes, and other differentiated tissues, revolves rapidly within its capsule. The evolution of the ova in these decaying adults is a feature analogous to the elaboration of the respective generative products in the headless fragments of male and female specimens of *Lineus marinus* and others,—the last efforts of the parental tissues being devoted to the reproduction of the species.

Dr. Max Schultze was the first to describe a viviparous species (his *Tetrastemma obscurum*). He states that in the development of the proboscis in the young animal the marginal stylets appear before the central, and as the worm grows older he figures it with two loose stylets in the pit of the proboscis, an arrangement, as he supposes, for the supply of the central organ. I have also seen a loose stylet or two lying in the anterior chamber of the proboscis, but this occurred both when there was and when there was not a stylet on the central apparatus. The physiology of that region, as previously explained, demonstrates that there is no connection between the marginal and central stylets, except, perhaps, in the composition of the fluid with which both are bathed. Professor Keferstein next detailed the development of *Prosorhochmus Claparedii*, a species in which the young attain considerable advancement before extrusion, for they are found with four eyes, a well-developed proboscis, and other organs in the body of the parent, and on being set free have the same general form as the latter (Plate II, fig. 4). M. Claparède subsequently made a few remarks on the same species, mentioning that he had seen specimens with ova in the sacs, but they were never numerous. By the examination of this species I have been enabled to confirm many of the excellent observations of the two foregoing authors, and to see that the development within the body is very similar to that of the free ova and their products. The larger young specimens are often doubled within the parent, and apparently invested by the stretched covering of the ovisac, or in large cavities produced by the coalescing of many ovisacs; at any rate, it is clear that to describe them, after the former authors, as simply within the body-cavity of the worm, is not strictly accurate. It is curious to see these large young animals moving within the body of the adult, apparently without causing the latter any inconvenience. Such, then, appears to be a further stage of the type of development seen in *Nemertes carcinophila*, in which, after the deposition of the majority, a few ova are left in the body of the parent for subsequent evolution. It remains, however, to be observed whether all the ova in *Prosorhochmus* are so developed (in which case they must be very few) or whether part are deposited at one or different periods, and the rest retained in the body of the parent. It is probable, at least, if the ova are numerous, that they are not developed simultaneously, as in other forms, else the adult would be inconveniently distended, and the young much compressed.

From the foregoing it will be seen that the viviparous species are connected by insensible gradations with the true oviparous forms. It may likewise be found that the former have a close connection (if they are not identical) with the hermaphrodite species described by Prof. Keferstein and A. F. Marion. In *Borlasia hermaphroditica*, Kef., the anterior genital sacs were full of spermatozoa, and the posterior of developing ova; while in *B. Kefersteinii*, Mar., the sexual elements appeared to be distributed throughout the whole length of the body, but whether alternately or otherwise the author does not state.

II.—Anatomy and Physiology of the Anopla.

1. *Cutaneous System.*

The skin in this group, of which *Lineus gesserensis* may be taken as the type of the majority, is closely allied to that of the Enopla, though its structure is frequently rendered obscure by the greater development of the pigment. The cilia are very active in the cephalic fissures, and it is sometimes noticed that their motion is suspended and again resumed without evident cause. In the living animal the cutis has a cellular aspect (Plate XVII, fig. 16), the cells or areolæ measuring about $\frac{1}{1000}$ of an inch, and most distinctly seen towards the tip of the tail in the adult. Sometimes a number of minute clear granules are placed over the larger cells, as shown at the lower third of the figure. The pigment-cells and granules reach their greatest development anteriorly, and some of the former contain very dark brownish-black pigment in circumscribed masses. The dorsal pigment has in general a longitudinally streaked appearance (Plate XVII, fig. 15), a state probably arising from the peculiar arrangement of the fibres of the external muscular layer hereafter to be described. In some pale red specimens the coloration is due to a uniform impregnation of the cutis, and the tint is much deeper than that of the ganglia, which are thus rendered conspicuous by their pallor. Occasionally one or two pigment-cells of exceptionally large size are present anteriorly (Plate XVII, fig. 18), each containing from one to three clear granules.

In transverse sections, underneath the ciliated epidermis (*c*, Plate XVIII, fig. 4), a somewhat thick layer (*d*), composed of granular cells and globules in areolæ, occurs. From the facility with which these contents escape, the drawings show the parts in a slightly altered condition. Beneath is a pale structureless basement-layer (*d'*), the presence of which in *Cerebratulus* had led Prof. Keferstein into the error of supposing it to be a layer of circular muscular fibres; but an attentive examination of that genus, as well as the present, demonstrates that, while one may be deceived if only transverse cuts are made, no doubt can exist in longitudinal sections. This point may readily be settled without reference to the more explicit, because larger, condition of the parts in *Lineus marinus*. A thick compound layer is next encountered in *L. gesserensis*, consisting externally of pigment-granules and cuticular globules (*d''*), and internally of a series of powerful longitudinal muscular fibres (*e*). Under a low power, indeed, this compound layer in transverse section appears as one, the pigment and other cells, and the ends of the muscular fibres, presenting a similar aspect. The amount of pigment varies, of course, in different specimens, and is always much more developed dorsally than ventrally. Towards the anterior end of the animal this coat (*d''*) becomes thicker, and its reticulations more distinctly marked. Fine longitudinal sections of the snout from above downwards show superficially a series of very beautiful reticulations of a somewhat regular aspect (Plate XVIII, fig. 10, *k*), the chief interstitial bands having a longitudinal direction. Towards the tip the texture becomes denser in transverse section (Plate XVIII, fig. 7), and the pigmentary matter increases, especially just within the pale external layer of the cutis. A section still further back (Plate XVIII, fig. 8) exhibits a less compact arrangement, and the pigment is now for the most part grouped into a dorsal and a ventral band. The general stroma consists of radiating and longitudinal fibres, the ends of the latter and the granular matter being often situated in the axils of the diverging series. The pigment anteriorly attains its greatest density immediately beneath the pale external layer of the cutis, diminishing in quantity from this point inwards (Plate XVIII, fig. 9). The snouts of these mobile animals resemble in structure the elaborate arrangements which are sometimes met with in certain organs (such as the tongue) in the higher animals, where extensive and delicate motions are combined with high tactile power.

To assist in the latter function, there are three papillæ on the snout, one of which, from its situation, falls to be described with the opening of the canal for the proboscis. The other two are placed on each side of the central (Plate XIX, fig. 1), but are not always so prominent. Each is furnished with a series of cilia of greater length than those on the general surface, and which extend from the papilla during erection in a radiating or fan-shaped manner. They are probably of great tactile service to the worm.

The cuticular cells are finer in *Lineus lacteus*, Mont., MS., and the dorsum is not clouded by the granular pigmentary matter. In *Lineus bilineatus* the arrangement of the two white dorsal stripes is characteristic, for the pigment is strictly confined to the region corresponding to *d''* and *e* in *L. gesserensis;* and in transverse section (Plate VI, fig. 7) they appear as two opaque patches with an intervening pale space, bounded externally by the basement-layer of the exterior coat, and internally by the circular muscular fibres. In *Borlasia Elizabethæ* the cutis in transverse section presents a dappled aspect (Plate XXI, fig. 4) from the intervention of pale patches between the dark-brownish masses. Certain peculiarities are observed in the dermal tissues of *Lineus marinus*, a species which has been taken as the type of the Nemerteans in this respect by M. de Quatrefages. The external cuticular layer (*d*, Plate XVIII, figs. 5 and 6) is proportionally thinner than in *L. gesserensis.* The pigmentary layer (*d'*, *d''*) is divided by a definite black band (2), and distinctly separated from the first or external longitudinal muscular coat by a curious translucent stratum (3, 3), presenting in cross section (fig. 5) a transversely barred arrangement with linear interruptions, which divide it into numerous and somewhat regular elongated spaces. In longitudinal section (fig. 7), again, this stratum has a wavy aspect, or, if much contracted, presents a series of moniliform streaks. That this layer, however elastic, is not muscular, a glance at the position of the parts in longitudinal section at once demonstrates. It belongs entirely to the dermal elements, and with the interior pigmentary layer corresponds to the region *d''* in *L. gesserensis*, which (region) in the larger species attains much greater development, and becomes distinctly separated from the longitudinal muscular fibres. A similar structure is found in the cutaneous tissues of a typical form of the Anopla brought by Mr. McAndrew from the Gulf of Suez, and also in the *Borlasia novæ-zealandiæ* of Dr. Baird.

The skin in many of the Anopla, *e.g. Lineus marinus*, *L. gesserensis*, *L. sanguineus*, *L. lacteus*, *Micrura fusca*, *M. purpurea*, and *M. fasciolata*, gives a marked acid reaction when tested with litmus-paper.

PLATE I.[1]

Fig.

1. *Amphiporus lactifloreus*, Johnston, pinkish variety. Enlarged.

2. ,, ,, whitish variety. Slightly enlarged.

3. ,, *pulchra* (O. F. M.), Johnst. Enlarged. The specimen is a female, and the bright reddish ova shine through the translucent integuments.

4. *Tetrastemma dorsalis*, Abildgaard. Enlarged. This variety has a pale dorsal stripe.

5. *Nemertes carcinophila*, Kölliker. Enlarged.

6. Everted proboscis and anterior end of *Nemertes gracilis*, under pressure. × 55 diam.

[1] The lines in the various plates indicate the natural length of the animals.

Printed in Colours by Mintern Bros.

G.H. Ford

PLATE II.

Fig.

1. *Tetrastemma melanocephala,* Johnston.

2. ,, *candida,* O. F. Müller. Head elongated.

3. ,, ,, Siskin-green variety, with the head contracted.

4. *Prosorhochmus Claparedii,* Keferstein, and young.

5. *Nemertes gracilis,* Johnst. Enlarged.

PLATE III.

Fig.

1. *Tetrastemma Robertianæ*, n. s.

2. *Amphiporus spectabilis*, De Quatrefages.

3. *Tetrastemma vermicula*, De Quatref., with the body slightly turned over in the middle.

4. ,, *dorsalis*, Abild. A very large and fine specimen.

5. Head of *Tetrastemma candida*, var.? From deep water, St. Andrews.

6. *Nemertes Neesii*, Œrst., in one of its usual spiral conditions.

7. Dorsal aspect of the anterior region of *Amphiporus spectabilis*, De Quatref. Enlarged under a lens.

8. Ventral surface of the same region in *A. spectabilis*. Enlarged under a lens.

Printed in Colours by Mintern Bros

G. H. Ford

PLATE IV.

Fig.

1. *Tetrastemma flavida,* Ehrenberg.

2. *Lineus gesserensis,* O. F. Müller, green variety, showing the generative apertures as a series of pale specks along the sides.

3. Small mucus-cord of the same species, with dull yellowish ova. Enlarged under a lens.

4. Pale variety of *Cephalothrix linearis,* Jens Rathke.

5. Anterior fragment of the same species, with reddish pigment at tip of snout. The digestive cavity is tinted of a fine deep green behind the œsophageal region, and the entire surface speckled with minute white grains.

Pl. IV

PLATE V.

Fig.

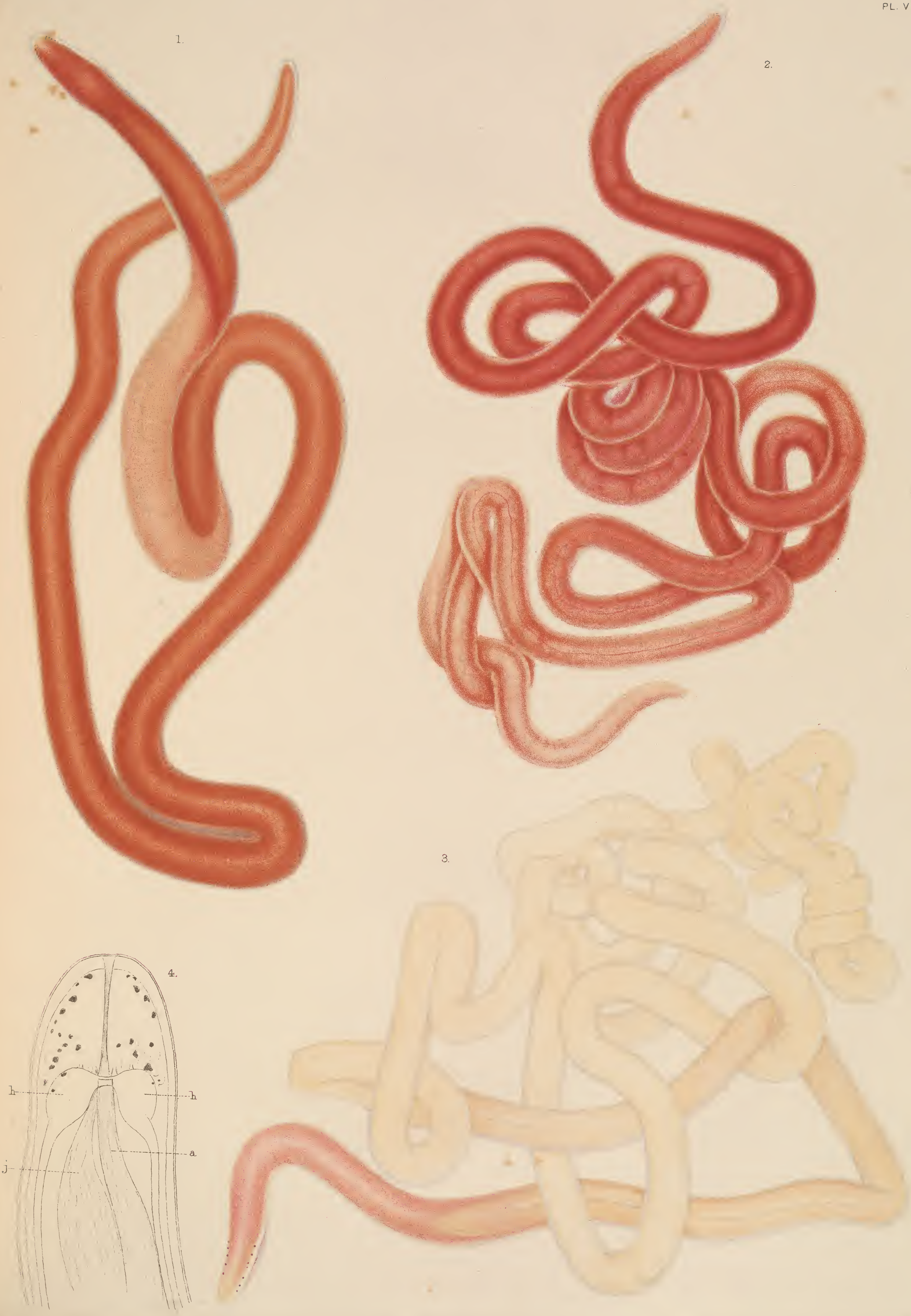
1. Reddish variety of *Lineus gesserensis,* O. F. Müller. Enlarged under a lens.

2. *Lineus sanguineus,* Jens Rathke. Enlarged.

3. *Lineus lacteus,* Montagu, MS. Enlarged.

4. Enlarged view of the head of *Nemertes gracilis,* seen as a transparent object.

PL. V



Robt.a M'ad nat. delt et pinxit.
Fig. 4 W.C.M. delt

Printed in Colours by Mintern Bros

G H Ford

PLATE VI.

Fig.

1. *Lineus bilineatus,* Delle Chiaje. Enlarged.

2. *Micrura fasciolata,* Ehrenberg. Enlarged.

3. *Micrura fusca,* n. s. Enlarged. The reddish band on each side is caused by the nerve-cord.

4. Young specimen of *Micrura fusca*? showing the early condition of the eye-specks, and the proportionally larger size of the head.

5. Portion of the tube of *Nemertes carcinophila.* × 55 diam.

6. Fragment of the outer surface of the same. × 350 diam.

7. Transverse section of the cutaneous tissues of *Lineus bilineatus,* so as to show the arrangement of the two white dorsal bands. × 90 diam.

Printed in Colours by Mintern Bros.

G.H. Ford

PLATE VII.

Fig.

1. *Borlasia Elizabethæ*, n. s. Enlarged.

2. Body of the same species contracted into a firm mass. About the natural size.

3. *Micrura purpurea*, Dalyell. Enlarged.

4. ,, *aurantiaca*, Grube. Enlarged.

5. Portion of the posterior end of *Carinella annulata*, showing the white specks which indicate the openings of the generative organs.

6. Head of a southern variety (reddish) of *Nemertes Neesii*.


1.
6.
2.
5.
3.
4.

PLATE VIII.

Fig.

1. *Carinella annulata.* The specimen from which the drawing was made was rather pale. Enlarged under a lens.

2. *Amphiporus hastatus*, n. s. Enlarged.

3. „ *bioculatus*, n. s. Similarly enlarged.

PLATE IX.

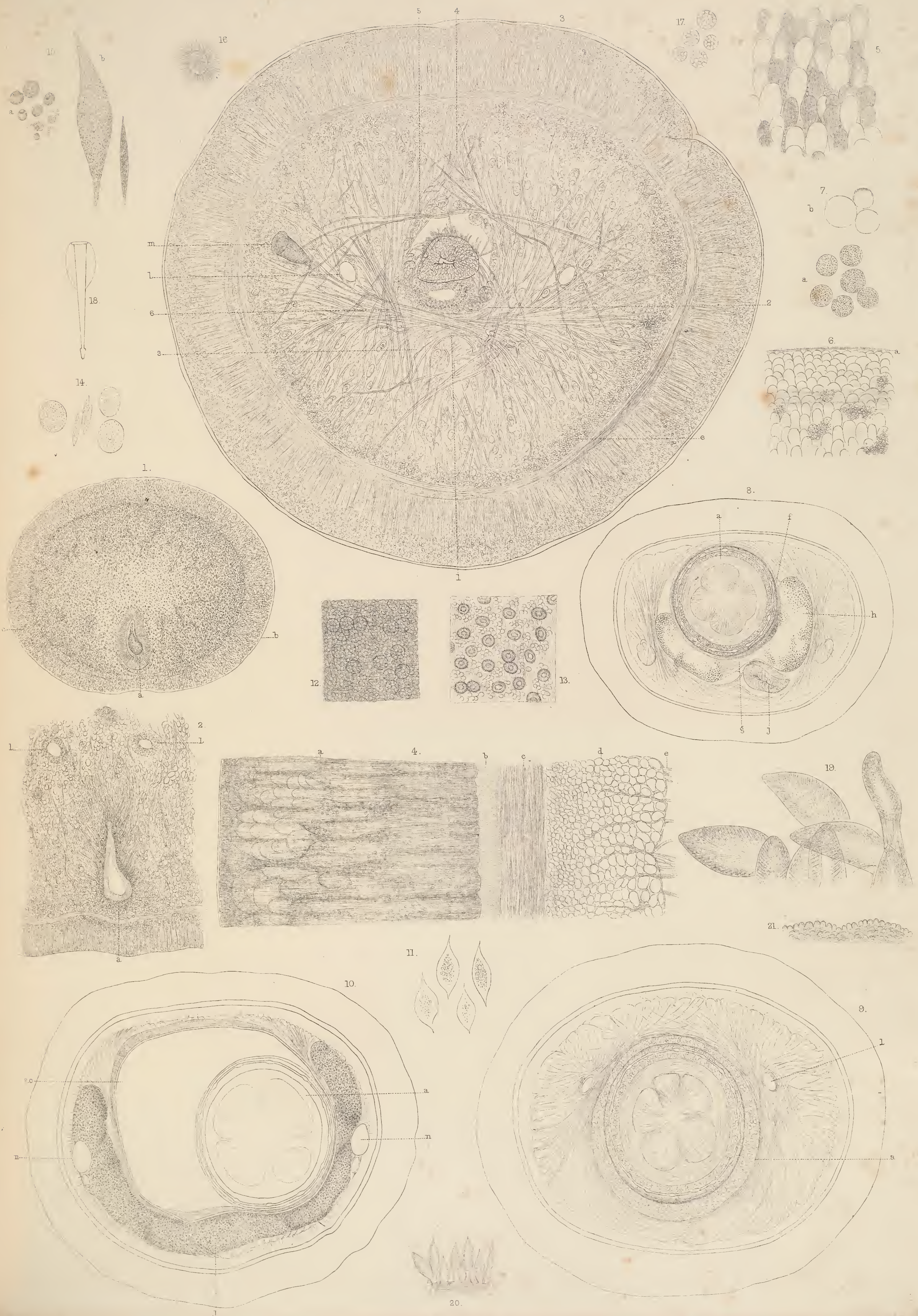
Slightly enlarged drawing of *Lineus marinus,* Montagu. The specimen was even more elongated than the figure indicates.

PLATE X.

Fig.

1. First transverse section of the snout of *Amphiporus lactifloreus*. *a*, aperture for the proboscis; *b*, delicate superficial film seen in recently mounted preparations; *c*, dermal layer. × 210 diam.
2. Section of the snout of the same species somewhat posterior to the former, showing the channel for the proboscis (*a*), and the cephalic blood-vessels (*l*), just before they complete the arch. × 210 diam.
3. Transverse section of the snout of *A. lactifloreus* in front of the ganglia, somewhat flattened from pressure. 1, 2, 3, 4, 5, 6, the various bands of fibres described in the text; *e*, longitudinal muscular fibres; *l*, section of cephalic blood-vessel; *m*, section of cephalic sac. × 210 diam.
4. Transverse section of the body-wall of *A. lactifloreus*. *a*, the cutis, with its cells and areolæ, somewhat compressed; *b*, structureless basement-layer; *c*, circular muscular coat; *d*, longitudinal muscular layer; *e*, delicate fibres proceeding from the latter to the viscera. × 700 diam.
5. View of a portion of skin snipped from a living specimen, under moderate pressure. × 350 diam.
6. Skin from the caudal region of a small example, under slight compression. *a*, the ciliated free margin. × 350 diam.
7. Elements of the skin as they escape from the living animal. *a*, granular cells; *b*, mucous or gelatinous masses having the appearance of oil-globules. × 350 diam.
8. Transverse section of the anterior part of the cephalic ganglia, in a specimen which had been put under chloroform and then immersed in strong alcohol, so as to protrude a small portion of the proboscis. The inferior commissure (*g*) is not much stretched, but the superior (*f*) is almost imperceptible; *j*, œsophagus. × 55 diam.
9. Section of the region anterior to the former in the same specimen. The invagination of the proboscis and the changes in the region surrounding it are well shown. *a*, the anterior and hence outer fold; *l*, cephalic blood-vessel. × 90 diam.
10. Transverse section of the body of a specimen of *A. lactifloreus*, in which no reproductive elements are visible. The dilatation of the proboscidian chamber (*o*) is characteristic, and the walls of the digestive cavity are pressed downwards and outwards. × 55 diam.
11. Corpuscles of the proboscidian fluid from *Tetrastemma flavida*. × 350 diam.
12. Portion of the glandular surface of the posterior chamber of the proboscis of *A. lactifloreus* in its normal condition. × 350 diam.
13. Portion of the inner surface of the same chamber viewed *in sitû* under pressure. The papillæ are hirsute, and their contents scattered over the surface of the organ. × 350 diam.
14. Corpuscles of the proboscidian fluid from *Tetrastemma dorsalis*. × 350 diam.
15. Corpuscles of the proboscidian fluid from *A. lactifloreus*. *a*, minute nucleated cells and granules; *b*, spindle-shaped corpuscles. × 500 diam.
16. The proboscidian aperture in the snout of the same species. × 210 diam.
17. Isolated gland-cells from the posterior chamber of the proboscis. × 350 diam.
18. Stylet from a marginal sac of *A. lactifloreus*, having an abnormal point, and the remains of a globule at the base. × 210 diam.
19. Glandular papillæ from the anterior region of the proboscis of *Tetrastemma vermicula*, seen on the free edge of the everted organ. × 700 diam.
20. Lanceolate and pedicellate papillæ from the first part of the anterior region of the proboscis of the same species. × 210 diam.
21. Portion of the everted inner surface of the posterior chamber of the proboscis. The glandular papillæ have for the most part burst and become minutely hirsute. × 350 diam.

Pl. X.



15

A

MONOGRAPH

OF THE

BRITISH ANNELIDS.

PART I Continued.

THE NEMERTEANS.

Pages 97—213*d*; Plates XI—XXIII.

BY

William Carmichael
W. C. McINTOSH,
M.D., F.R.S.E., F.L.S., ETC.

LONDON:
PRINTED FOR THE RAY SOCIETY.

MDCCCLXXIV.

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

2. *Muscles of the Body-wall.*

The longitudinal muscular coat (*e*, Plate XVIII, fig. 4), which is incorporated with the cutaneous layer (*d″*) at its commencement, is thick and powerful, and has a well-marked fasciculated aspect in transverse section. At the sides of the mouth, where it attains great development, and forms a strong lateral support, there is a very pretty radiate or somewhat arborescent arrangement of the interfascicular substance in transverse section (Plate XX, fig. 1). This appearance is due to numerous radiating fibres, which pass from the inner longitudinal layer through the circular coat, and then diverge widely in the great muscular mass (Plate XX, fig. 13). It is best seen in the neighbourhood of the lateral nerve, where the muscle is most developed, and especially in partially decomposed specimens. So thickly are these fibres placed, that they pass through the slightly coloured stroma surrounding the nerve. Such a condition permits great stretching in all directions without actual separation of the muscular bundles, and is thus eminently adapted for the functions of the parts. The intimate connection of the outer fibres of this layer with the adjoining coat is well brought out in some longitudinal sections of the body, which show the outer bundles of fibres quite separated from each other by rows of pigment- and other cells and granules, the whole having a curiously streaked appearance. Anteriorly this longitudinal layer becomes lost in the tissues of the snout. The next coat (*e′*) consists of a series of circular muscular fibres of considerable thickness, between which and the former the nerve-trunks are situated. It extends forward by the ganglia, and appears to merge into the wall of the passage for the proboscis in front of these organs. Within the last-mentioned coat is a layer (*e″*) of longitudinal muscular fibres, similar in structure to the corresponding stratum in the Enopla. It also passes the ganglia to become connected with the muscular channel for the proboscis in the snout. The several muscular layers retain nearly the same relative proportions towards the posterior end of the worm (Plate XVIII, fig. 11).

The cutaneous and muscular coverings of *Lineus sanguineus* are thinner than in *L. gesserensis*, but conform exactly to the same type. The only peculiarities observed in the muscular coats of *Lineus marinus* are the very evident transverse streaks of the external longitudinal (Plate XVIII, fig. 6, *e*), and the presence of certain cellular masses in it and the next outer layer. These bodies (Plate XXII, fig. 5, *a*) lie in definite spaces (*b*), and consist of groups of rounded cells filled with granules. In the contracted state of the animal, as after preservation in spirit, the circular coat in longitudinal sections has a wavy aspect (*e′*, Plate XVIII, fig. 6), apparently from the extreme shortening of the parts. In *L. bilineatus* the circular muscular layer is thicker than in *L. gesserensis*, a condition probably connected with the somewhat rounded form of the worm. The enormous muscular layers in *Borlasia Elizabethæ* (Plate XXI, fig. 4) have a fine red hue, so that the resemblance in this respect to the muscles of the higher animals is striking. The reddish coloration is most intense on each side of the circular coat all round, especially at the region of the nerve-cords, which are paler than their investments. The circular muscular coat is less tinted than the others, and forms a distinct line of separation between them. In this species, also, the fixing of the longitudinal fibres by the interfascicular substance is very favourably seen. In certain *Lineidæ* from Shetland the inner longitudinal muscular layer surrounds the sheath for the proboscis (Plate XXI, fig. 3), a feature of considerable physiological importance.[1]

In spirit-preparations of *Micrura fusca* the anterior third, especially if distended by the proboscis, is rounded, but the rest of the body has on each side a prominent thin margin, which in transverse section presents a great contrast to the same parts in *L. gesserensis.* The muscles on the whole are thicker, and the body more depressed in contraction. The circular muscular coat forms a flattened ellipse. The inner longitudinal layer is much diminished opposite the nerves, increases in bulk near the central dorsal region, and again abruptly tapers on each side of the median line, so as to form a broad wedge for the arch of the proboscidian sheath. It also increases in thickness towards the centre of the ventral surface, only a slight concavity occurring at the median point. The external longitudinal coat, however, presents the most typical deviation, for at each side, opposite the nerve-trunks, it extends outwards in the form of a prominent triangular process (in transverse section), the layer being then gradually narrowed towards the dorsal and ventral surfaces. In *Micrura fasciolata* the brownish-red pigment on the dorsum penetrates even to the circular muscular coat, but at other parts it is confined to the region without the external longitudinal muscular layer.

The posterior end of the body in *Micrura* requires special mention, since there is superadded a peculiar attenuate and contractile style. This appendage (Plate XVII, fig. 21) seems to be formed by a prolongation of the cutaneous and part of the muscular (longitudinal and circular) textures of the body-wall of the animal. The entire organ in contraction has a granular appearance, the coarsest granules, and occasionally a few circular masses of brownish pigment, being at the tip. Within is a central chamber (*a*), which undergoes various alterations in size, and contains a transparent fluid. This cavity is not connected with the digestive tract, which opens by a terminal pore (*z*) at the base of the process, nor can proboscidian discs be seen therein. I have not as yet ascertained with what system it communicates, but its connection with the circulatory appears most probable. The style is richly ciliated externally, and undergoes many and varied motions, now forming a verrucose knob, now stretched to an extreme degree of tenuity, and apparently assisted in the latter action by the fixing of the tip, the warty formations of which seem to perform the functions of suckers; for the animal may be observed progressing with a loose style, then the tip of the latter suddenly becomes fixed upon the clean and smooth glass, and the whole organ is gradually elongated. The fixed portion at the tip is usually more dilated than the succeeding part of the style. Prof. Grube thought the caudal process of certain Nemerteans might be due to reproduction of the tail, but, of course, this view is inapplicable to the foregoing.

a. Body-wall in the Carinellidæ.—In *Carinella annulata* the cuticular cells or areolæ are smaller (Plate XVII, fig. 17), but they have the same arrangement, and retain much of their shape after mounting (Plate XXI, fig. 3). The characteristic opaque-white dorsal and lateral pigment-stripes pass throughout the entire dermal tissue, while the white specks on the sides (apparently corresponding with the openings of some of the genital sacs) do not traverse the whole thickness, but lie towards the inner border.

There are only two muscular layers, an external circular coat (*e′*, Plate XXI, fig. 3), and an

[1] The animal in the British Museum termed "*Gordiophis subterraneus*" is an ordinary example of the same family.

inner thicker longitudinal (*e″*). The circular muscular fibres surrounding the digestive chamber, however, are unusually powerful. In a curious specimen from Balta, with a bifid proboscis and other peculiarities, the arrangement, which shows, perhaps, only an abnormality of this type, is as follows:—Externally (Plate XXII, fig. 2, *d′*), beneath the basement-layer of the cutis (which in the fragmentary specimen was almost absent), is a coat of circular fibres (*e′*). Within the latter is a very powerful layer of longitudinal fibres (*e*), which (layer), however, is not continuous, as in the ordinary form, but has at least one very distinct point of separation. On approaching the middle line of the dorsum, this longitudinal coat becomes thinned, so as to end on each side of the centre in a blunt point. In addition, a somewhat triangular portion (*ea*) is cut off by interfascicular substance and fibres. The dorsal curve of the proboscidian sheath is closely applied to this central point of separation, apparently receiving therefrom a few fibres, which retain it in position, while other fibres pass downwards to join the circular layer (*ja*), which here encloses the space for the digestive tract. The separation of the great longitudinal layer of the body-wall is marked externally by a distinct median line, which is rendered more conspicuous by the occurrence of the transverse striæ of the dorsum on each side of it. There is also a slightly marked median fissure in this muscular coat inferiorly. A pale, eyeless species (*Carinella linearis*), from Lochmaddy, shows a similar arrangement, for the inner longitudinal layer in transverse section is narrowed towards the centre of the dorsum, with traces of a separation by interfascicular substance. The fasciculi of the longitudinal muscular coat in this species and *C. lineformis* are arranged in a linear manner, the rows passing from without inwards.

b. Body-wall in the Cephalothricidæ.—The dermal tissues of *Cephalothrix* are exceedingly transparent, the pigment, when present, being only developed in the snout in front of the ganglia as a rose-pink or reddish shading within the superficial portion of the cuticular layer. The action of the cilia is most vigorous in the cephalic region. The cutis (*d*, Plate XXI, fig. 2), composed of the usual granular cells and gelatinous matter in areolæ, has on its inner margin a trace of a translucent homogeneous basement-layer. A very thin band of circular fibres (*e′*) comes next, the exact structure of which is best demonstrated in fresh animals, after the addition of a little dilute acetic acid. The fibres are also evident in fine longitudinal sections, but are not satisfactorily seen in transverse cuts on account of their tenuity. Beneath is a very powerful longitudinal muscular coat (*e″*), the ends of the fibres having the usual fasciculated appearance,—the inner being somewhat coarser than the outer. At each side a distinct increase occurs at the region of the nerve, where the layer is separated into two portions by a septum of fibres from the circular coat, the nerve lying in the line of demarcation. This arrangement is quite characteristic, and the position of the nerve-trunk probably points to the compound nature of the great longitudinal layer, viz., as analogous to the two longitudinal layers in *Lineus*, the circular muscular fibres cutting off only the lateral portions (*e*), instead of dividing it completely. This genus shows the mobility of the race even in a greater degree than the others. In progression the long yielding snout is used as an exploratory or boring organ, which it stretches hither and thither with ceaseless energy, and by its aid pushes aside its own mobile body in any direction; while through a narrow loop of mucus the latter is drawn like a thread of semi-fluid, yet coherent substance. The animal also moves readily on the surface of the water. When tested with blue litmus-paper the skin gives a most vivid red stain.

Delle Chiaje mentions only two muscular coats in his *Polia sipunculus*, an outer of circular muscular fibres, and an inner of longitudinal. He does not notice the external longitudinal layer.

A similar omission is made by Huschke, in describing his *Notospermus drepanensis*, which he provided with an external longitudinal and an internal circular layer. H. Rathke gives *Borlasia striata* two coats—an epidermis and a corium—combining under the latter both the pale and the pigmentary portions of the skin. He has not noticed the external longitudinal muscular layer, and mentions only an outer circular and an inner longitudinal muscular coat. It is somewhat difficult to comprehend the views held by M. de Quatrefages with regard to the same structures, since his descriptions and figures do not seem to coincide with each other. He divides the skin into three coats, viz. the ciliated epidermis, cutis, and the fibrous coat. Moreover, the cutis has two layers—an outer, formed of a homogeneous transparent substance, presenting in its mass a number of cells or simple rounded vesicles, refracting the light, and an inner, of large elongated cells in a double row; but in his figure the muscular elements occupy a bulk so insignificant that some error appears to have been committed, especially as the third layer of the skin is stated to be a transverse fibrous one. It is at all events difficult to see how the enlarged transverse section in pl. 23, fig. i, agrees with his figures iv and v, pl. 18, of the 'Voyage en Sicilie.' Two muscular coats only are described by this author—an external longitudinal and an internal circular—the internal longitudinal being omitted, or rather considered an aponeurotic layer. He also commits a serious error in affirming that the structure of the dermal tissues in the Enopla corresponds with that in *Borlasia angliæ.* Frey and Leuckart likewise describe only two muscular coats—an outer longitudinal and an inner circular. Prof. Keferstein, while representing the cutaneous textures of *Cerebratulus* (one of the Anopla) with greater accuracy, also falls into the mistake of applying what he found in this animal to all the Nemerteans. He describes two coats in the skin — a cuticula covered with cilia, and an inner thick, finely granular layer which contains the pigment—a definition which is scarcely comprehensive enough for the nature of the parts in such as *Lineus marinus.* He mentions the occurrence of crystals of the form of arragonite in the pigmentary layer of *Cephalothrix ocellata,* but such have not been seen in the British forms, except under the action of chemicals, or after the evaporation of the salt water. He also refers to a "transverse" tactile papilla on the snout of his *Cephalothrix longissima,* which resembles a slight protrusion of the lining membrane of the canal for the proboscis. His statement, that in *Cerebratulus marginatus* there are four muscular coats—an external circular under the pigment-layer of the cutis, a longitudinal, a circular, and lastly an internal longitudinal —has already been noticed. No more than three muscular coats are present in the *Lineidæ.* Lastly, Dr. Anton Schneider,[1] in his remarks on the muscles of worms, and their importance in the system, states that in *Nemertes* the following layers occur:—Circular, longitudinal, and circular, besides radiating muscles—a description that is unsatisfactory as regards the British species.

The elaborate system of muscles in the body-wall of these worms enables them to perform the most varied and complex motions, so that they have not inaptly been compared to a piece of living caoutchouc. When irritated, the larger species, such as *Lineus lacteus,* Mont., and *L. sanguineus,* suddenly contract in a spiral manner like a cork-screw or the stalk of a Vorticella, or twist their bodies into a rope of various strands. The great *Lineus marinus* may now and then be observed in its native pools extended between the Fuci of opposite sides in numerous loops, each several yards in length, and so intricately arranged that they can scarcely be unravelled

[1] 'Archiv für Anat.,' 1864, p. 595.

by other than the animal itself. The extreme stretching which the body undergoes before it snaps—as in attempting to secure a specimen in an intricate and inaccessible pool—and the extraordinary shortening on immersion in spirit, are only well-marked conditions into which the animal throws its yielding textures at will. *Borlasia Elizabethæ* contracts itself so firmly during life as to form a hard flattened mass, which somewhat resembles the siphonal process of a Mya (Plate VII, fig. 2). *Micrura fusca*, again, swims freely on its edge like a freshwater Nephelis, or its own ally *A. pulcher*, lashing the water with alternate strokes of its muscular and flattened posterior extremity. Sir J. G. Dalyell likewise noticed this edge-motion in his great "*Gordius*" *fragilis* (*Cerebratulus angulatus*), but he was not sure whether it was a natural condition, or caused by the confined vessel. *Carinella annulata* secretes in captivity a beautiful silky sheath, within which it lies in comparative security, until, tempted perhaps by love of change, it searches for a fresh site, whereon to manufacture a new chamber for its protection. In unhealthy and slowly dying animals the skin becomes raised into pale bullæ, not only from corrugation, but from degeneration of the dermal textures.

3. *Proboscidian Aperture.*

A channel, ciliated for some distance, leads inwards from the terminal pore of the snout to the reflection of the proboscis just in front of the commissures. This channel, shortly after its commencement (Plate XVIII, fig. 7, *a*), is surrounded by an elaborate series of muscular loops (indicated at 2), which, while keeping it closed under ordinary circumstances, permit of rapid and easy dilatation. Immediately below is a series of longitudinal muscular fibres, which attain a more distinct development somewhat posterior to this point (*a*, Plate XVIII, fig. 8). A very beautiful group of circular and diverging fibres lies outside the first series (2, in the last-named figure), crossing each other in a striking manner superiorly and inferiorly, as well as less distinctly at intermediate points, and forming with the longitudinal and other fibres the intricate stroma of the snout. The terminal pore is furnished with a prominent papilla, covered with a fan-shaped brush of cilia, the whole being only occasionally extruded, and no doubt assisting the papillæ previously mentioned in the tactile functions of the snout. This central papilla is sometimes bilobed, each division being supplied with cilia. In spirit-preparations of large examples of *Lineus marinus* the proboscidian aperture is distinguished by a slight slit on the inferior surface immediately behind the tip of the snout, the minute anatomy and relations of which agree very closely with the same parts in *L. gesserensis*.

4. *Proboscidian Sheath and Chamber.*

The proboscidian sheath forms a shut sac, as in the Enopla, from the bridge of the ganglionic commissures to the posterior end of the worm. The long proboscis glides smoothly in this chamber, the walls being united with it and other tissues just in front of the commissures. The other contents are the clear proboscidian fluid and its discs. The latter are circular granular bodies, similar to, though smaller than, those of the Enopla, and when seen on edge present a fusiform outline, having a dilated middle and two tapering ends. There are also a few small granules and granular cells. The muscular wall and other parts of this chamber agree so closely, both structurally and functionally, with the same parts in the Enopla, that it is unnecessary to describe further than refer to the aspect of the parts in the living animal (Plate XIX, fig. 1, *o*); and to the various transverse sections, in which the wall of the chamber is lettered *o*, and the cavity *ao*. Sometimes near its diminished posterior end the latter shows a series of moniliform spaces, from internal bridles, and often does not quite reach the tip of the tail.

In *Carinella annulata* the proboscidian sheath is not continued to the posterior end of the worm, and it is an interesting fact that this absence coincides, as in the next group, with greatly enlarged lateral vessels.

The chamber is divided throughout its entire length in *Cephalothrix* by transverse bands of contractile tissue, so that during the motions of the worm the anterior region is occasionally thrown into many moniliform spaces. These contractile septa (though imperfect in the middle), doubtless prove of much service during rupture, an occurrence so liable in this slender animal. Moreover, the wall of the chamber is thin, and the circular muscular fibres of the body not much developed; hence the advantages afforded by these safeguards against the inconvenient distension of the chamber during the motions of the worm. The transparent liquid in the cavity contains flask-shaped bodies and minute clear corpuscles.

Professor Keferstein seems to have had no definite idea of this chamber as a cavity with special muscular walls, but speaks of the peculiar discs as floating in the body-cavity (Leibeshöhle)—an error of some importance. In his two transverse sections of *Cerebratulus marginatus* he appears to have confounded the wall of the tunnel with that of the proboscis. He is thus less correct than several of his predecessors, who noticed the sheath of the proboscis and its contents.

5. *The Proboscis.*

The proboscis in the *Lineidæ* (Plate XIX, fig. 1, *a*) commences in the form of a somewhat slender tube just in front of the commissures, gradually enlarges, continues for a considerable distance of nearly equal calibre, and then, diminishing, terminates posteriorly in a long muscular ribbon (ψ, sometimes bifid), which, curving forward in the ordinary state of the parts, becomes attached to the wall of the proboscidian tunnel. Its cavity passes in front into the canal of the snout, and posteriorly terminates in a *cul-de-sac* at the commencement of the muscular ribbon. It differs from the organ of the Enopla in certain respects, such as the absence of stylets, its more slender proportions, and the shape of the glandular papillæ on its internal surface. Experience, indeed, generally enables the observer to distinguish by external characters the proboscis of the Anopla from that of the Enopla in spirit-preparations—by the abrupt diminution of the calibre at the posterior portion in the latter, caused by the presence of the stylet-region and globular reservoir; but where the organ is incomplete, a transverse section at once puts the question beyond doubt. There are, also, in the proboscis of the *Lineidæ* three longitudinal lines, the first of which corresponds to the intersection of the fibres at one pole, and the other two occur at the ends of the separate segment, hereafter to be described. In the living animal the organ is proportionally longer than in the Enopla, and when rejected is thrown into numerous screw-like coils.

In transverse section there is externally an investment (*a*, Plate XX, fig. 4, and Plate XIX, fig. 8) similar to that in the Enopla, apparently composed of homogeneous elastic tissue, yet showing some granular markings towards its outer border. This coat is tougher than any of the others, and often retains its integrity after they have ruptured. A powerful longitudinal muscular layer (*b*) lies within the former, its fibres in transverse section having the same histological characters as in the Enopla. At opposite or nearly opposite poles of the circle, however, a remarkable interposition severs the continuity of the layer (as seen at *g*, *g′*). At one pole, two symmetrical bundles of fibres spring from the succeeding circular belt, and, slanting outwards, cross each other, so as to disconnect the longitudinal coat just mentioned, and for a portion of its circumference wedge it between two bands of circular fibres. The outer or oblique bands of circular fibres become lost in the external coat of the organ. The longitudinal layer (*b*) is thus diminished to a blunt point on each side of the intersection of these peculiar fibres, and a region is formed externally which is occupied by a special and somewhat lozenge-shaped group of longitudinal fibres, through which the dotted line *g* passes. The longitudinal layer, especially near the wedge-shaped ends (where the fibres are often arranged in a thicker mass in these preparations), is marked in the centre by a faint linear streak, as if composed of two layers, but this does not continue all round, and is not apparent in every specimen, nor in *L. gesserensis.* At the other pole there is a variation, for it is found that an elongated portion (*g′*) is cut off without apparent intersection, the ends of the great longitudinal coat (*b*) being widely separated. It generally happens that towards this side the bulging of the contracted organ occurs, and, it may be, such forces the edges of the longitudinal fibres apart, and aids in causing the above appearances; but it would not account for them all. In contraction this coat is sometimes thrown into a silky belt of regularly waved fibres. Within the longitudinal layer is an equally powerful one of circular fibres (*c*) which, at opposite poles in the transverse sections, gives off the peculiar oblique bands previously mentioned. A basement-layer (*d*), better marked in *Micrura fusca* than in *Lineus gesserensis,* is situated on the inner surface of the circular coat. There is also present in the former species an incomplete belt of longitudinal fibres (*e*) within the basement-layer, and which is not evident in the latter. Attached to the inner surface of the basement-layer, or in the latter instance partly to the incomplete longitudinal, is the glandular mucous coat (*f*), which, from lengthened preservation, has in this case become somewhat altered. The glandular bodies are scattered chiefly towards its inner or free surface. In fresh preparations, *i.e.* in those made from the organ immediately after extrusion from the living animal, a regularly radiate arrangement of this coat is constantly observed, as if a series of explosions had occurred in the mucous substance so as to scatter the globules and gelatinous bands in a fan-shaped manner. Indeed, the aspect resembles thick and graceful tufts of grass with large spikes, for the granular glands are mostly at the tips of the streaks of mucus, a state probably due to their passage outwards under compression. Professor Keferstein figures this in *Borlasia splendida,* but he does not refer thereto in his descriptions. In the fresh specimen the glandular papillæ are much smaller than in the Enopla, and widely different in shape (Plate XVII, fig. 20, and Plate XVIII, fig. 14), the former representing them in the extruded proboscis, the latter as viewed from without. Under ordinary circumstances they have an ovoid form, and vary from $\frac{1}{1500}$th to $\frac{1}{2000}$th of an inch in size. Under pressure they become either flattened circular bodies, or assume a cylindrical and slightly barred aspect; and, after escape into the surrounding water, the contents are club-shaped or rounded (Plate XVIII, fig. 12).

The usual cross of fibres occurs at one of the poles of the transverse section of the proboscis of *Lineus marinus* (Plate XXI, fig. 5), but the separate piece at the opposite pole is somewhat larger than in *L. gesserensis.* The proboscis of *Cerebratulus angulatus* (Plate XXIII, fig. 18) differs from the foregoing at one of the poles of the circle in transverse section. The layer of circular fibres is divided into two bands, one of which (the inner) passes continuously round, while the outer, after the usual intersection at one pole, diverges much more at the other, so as to make a triangular space between its fasciculi. In the space thus formed is situated a band of longitudinal fibres (*g a*). Further, in the outer angle of the cross, that is, in a position agreeing with the wedge of fibres at the opposite pole, a narrow belt of longitudinal fibres exists (*g b*). In the *Lineus acuticeps* of Dr. Baird, from St. Vincent's, West Indies (L. Guilding's collection, British Museum), the cross made by the fibres is entirely absent, and this coincides with a continuous and powerful longitudinal muscular layer within the circular coat. The latter (inner longitudinal coat) also occurs in an example of the *Lineidæ* collected by Dr. Cunningham in Elizabeth Island. The *Lineus novæ-zealandiæ* of Dr. Baird, again, agrees with the ordinary British forms in regard to layers, but there is no cross of fibres at one pole. A small form from Greenland also shows no intersection of the fibres, but the circular coat is divided by a median line into two layers, and there is a complete inner longitudinal coat. In *Borlasia Elizabethæ* the white proboscis is extremely slender in proportion to the bulk of the animal, and, moreover, the walls are comparatively thin. Instead of the shrinking and condensation which usually occur on immersion of the organ in spirit, a considerable central cavity remains in this case. Externally in transverse section (Plate XIX, fig. 7) is a thin investment, which generally shows a central line, as if divided into two layers. Beneath is a coat of longitudinal fibres, and then a thin belt of circular fibres with the ordinary glandular lining. The papillæ of the latter are small, rounded, and minutely granular. *Meckelia asulcata* is distinguished from other *Lineidæ* by the structure of its proboscis (Plate XX, fig. 5), which has externally no distinct superficial layer. Its outer coat consists of densely woven spiral fibres, which at opposite poles in the sections cross each other more distinctly than at other parts. The next (inner) coat consists of a considerable layer of longitudinal fibres, upon which the glandular papillæ rest.

In *Micrura* the organ is furnished with somewhat slender papillæ, which assume various shapes under pressure. When viewed laterally, the rounded or flattened papillæ, that formerly seemed only granular, appear to be composed of a series of minute rods set closely together (Plate XVIII, fig. 13). In some, however, the striæ are longitudinal. When extruded from the organ into the water, the cylindrical bodies in the papillæ cling together in some instances like fibrillæ; and the appearance in the prepared specimens is quite characteristic, the inner surface being covered with a vast number of these elongated structures. The latter are the bacillary bodies described by Dr. Max Müller, but I have never seen in the British species any of the urticating organs mentioned by this author. The anatomy of the organ in this section agrees with that in *Lineus,* and in spirit-preparations the shrinking causes a protrusion of tissue at the separate segment opposite the intersection of the fibres.

In *Carinella annulata* the proboscis has externally a thin investment composed of two layers (Plate XX, fig. 6), the outer consisting of elastic and the inner of circular muscular fibres; then a thick layer of longitudinal fibres is met with, and, lastly, a coat of circular fibres, to which the glandular lining is attached. Rod-like bodies occur in the papillæ of the latter coat, as in other forms, and seem to be analogous to the "stabförmigen Körperchen" of Professor Kölliker,[1] and other investigators of the structure of the Annelida. In the *Carinella* from Balta, the proboscis proceeds from the tip of the snout in the usual manner, but instead of the posterior end diminishing insensibly into the long muscular fasciculus, the organ divides into two nearly equal trunks (Plate XXI, fig. 9), each about as large as the entire portion, and terminating in a somewhat abrupt and dilated end, to which a long muscular ribbon is attached. The wall of this peculiar proboscis, so far as I could make out from the single and rather unfavourable example, had the following structure :—A circular layer showing a few granules on the outer margin in transverse section occurs externally; within is a powerful and apparently continuous longitudinal muscular coat, from the inner surface of which the granular papillary mucous lining projects. The inner or free margin of the latter is comparatively smooth, a result probably due to the minuteness of the papillæ. Each limb of the fork has the same structure as the anterior region, and the thick longitudinal coat, after bending inwards at the posterior end of the dilated termination, becomes continuous with the muscular ribbon. The proboscis thus differs from the ordinary form in the *Carinellidæ* in the bifurcation, and in having no distinct circular coat within the longitudinal. It has no closer analogy with any other type.

In *Cephalothrix* the papillæ of the proboscis are acicular, and longest anteriorly (Plate XVIII, fig. 15). In transverse section the walls present a simpler structure than in *Lineus;* but, though in the living animal an external circular and an internal longitudinal muscular coat are apparent, the tissues become so confused after mounting, that I have not satisfactorily unravelled them.

Under the action of powerful irritants, such as alcohol, the *Lineidæ* detach, in their spasms, both the anterior and posterior connections of the proboscis at once, so that the extruded organ remains in its ordinary condition when expelled, and is not everted. In *Cephalothrix*, again, it sometimes ruptures near the ganglia, and is drawn backwards by the ribbon of attachment and its own elasticity ; the animal apparently being unaffected by the injury, which regeneration soon repairs. I have never seen the worm use the proboscis for any purpose ; and though M. van Beneden has observed it extruded in *Cerebratulus Œrstedii* (*Lineus bilineatus*), and threatening its prey, I fear it could not do much harm. The lifelike vermicular motions of this muscular tube, both *in sitû* and when cast off, have misled Mr. Beattie and others, so that they described the organ as a young animal, and the possessor as viviparous, or even considered the expelled portion a parasite. This is at once apparent on examining Mr. Beattie's specimen of the supposed young animal in the British Museum. The proboscis is reproduced in the same manner as in the Enopla; and the discarded organ, if not ejected, may be seen floating in the proboscidian cavity amidst much granular débris. Sir J. Dalyell states that the usual colour of the proboscis in *Lineus marinus* is vivid red ; our specimens have generally had white or faintly pinkish organs.

M. van Beneden does not mention the tissues to which the muscular retractor of the proboscis is attached in his *Nemertes communis*, and speaks of it as suspended freely in the cavity of the body, like the digestive tube of the Bryozoa. A further remark with regard to the organ in

[1] *Vide* 'Kurzer Bericht über einige im Herbst 1864 an der Westküste von Schottland,' &c., pp. 12, et seq.

Cerebratulus Œrstedii (*L. bilineatus*) makes his error still more apparent, for he says—"Toute la trompe se meut librement dans la cavité intestinale." Prof. Keferstein gives a small figure of a transverse section of the organ in *Cerebratulus marginatus* turned inside out; but, though he indicates the lozenge-shaped space formed by the intersection of the fibres, it is misplaced on one side, and the entire figure is too indistinct for reference.

6. The Digestive System.

a. Mouth.

The mouth in *Lineus gesserensis* is a longitudinal fissure on the ventral surface, situated a short distance behind the ganglia, and varying in size according to the motions of the animal, and the degree of contraction or relaxation. Its ordinary appearance under examination is represented in Plate XIX, fig. 1, *w*. Certain broad pale lines radiate from the lips of the fissure, an arrangement which led Dr. G. Johnston into the error of considering the mouth a nerve-ganglion and the furrows branches. These radiating lines or folds are due to the same structural cause as in the ciliated œsophageal region of the Enopla—viz., prominent longitudinal rugæ of the thick glandular texture of the organ, which, in this case, permit great dilatation of the parts during ingestion. The number of these rugæ varies, as may be observed by a comparison of the figures. When *L. gesserensis* is killed by immersion in fresh water the mouth frequently presents five or six somewhat triangular folds of the œsophageal structure, which fill up and distend the aperture. The mouth is very conspicuous in *Lineus marinus* (Plate XVIII, fig. 2). In *Lineus lacteus* it is situated very far back (Plate XIX, fig. 3), so that a long space intervenes between it and the ganglia; and there is a marked difference in this respect between the present species and *L. sanguineus* (Plate XIX, fig. 2).

In *Carinella* the oral aperture forms a longitudinal slit, somewhat less conspicuous than in *Lineus*. In *Valencinia lineformis* the mouth is quite as distinctly marked as in any example of the latter, and placed far backwards.

In *Cephalothrix* the lips of the aperture are frequently thrust outwards in the form of a short funnel, so that the animal resembles an elongated Distoma. Some circular fibres are present round the mouth in this group, and probably exist also in *Lineus*.

b. Œsophageal Division.

The mouth leads into a large ciliated œsophageal chamber (*j*), which commences anteriorly in the form of a *cul-de-sac* behind the ganglia and cephalic sacs, and nearly closes by its anterior wall the vascular lacunæ there, while it may be said to terminate posteriorly at a distinct incurvation of its wall, by becoming continuous with the digestive cavity proper. In transverse section (Plate XX, fig. 1), the anterior part of this chamber is seen under favourable circumstances as a thickly folded glandular mass (*j*), with the ventral slit (*w*) leading quite freely into it. The cavity has not yet attained its full size, and the mouth is severed at its anterior border. Superiorly, a large space is occupied by the proboscidian sheath (*a*), and the great lacunæ (*s*, *s*), and indications of some other vascular meshes are seen at the sides. The margins of the mouth (*w*) curve inwards, and gradually merge into the ciliated glandular texture of the cavity. A little further back the glandular substance is confined to the inner surface of the body-wall (though not closely applied thereto), leaving a large central space. In full perfection the chamber and glandular texture are seen in Plate XX, fig. 3. The minute structure of the wall of this portion of the digestive cavity is similar to that of the ciliated œsophageal region in the Enopla, being composed of a thick layer of granular gland-cells and basement-substance, raised here and there into prominent rugæ, and possessing a rich coating of cilia on the inner surface. The incurvation of the borders of the region is an interesting circumstance, and demonstrates the distinction between it and the succeeding division, even from the earliest condition of the worm, without for the moment regarding the other cardinal facts relating to the peculiar arrangement of the circulating channels on the walls, the thicker texture of the latter, and the total absence of the gregariniform parasites. Moreover, it is only in this region that the cilia of the digestive cavity are apparent, probably because the greater firmness of the walls keeps the chamber somewhat distended. In certain lateral views of the animal (Plate XXII, fig. 4), the distinction between the œsophageal and the succeeding region is very evident, the point of junction being inflected in a characteristic manner.

Though in the various drawings of transverse sections of *Lineus* this chamber (œsophageal) is seen in its normal condition, it is well to remember that it undergoes very marked alterations in size, according to the condition of the proboscidian cavity in its vicinity, for the proboscis most readily distends the latter in this region, and bulges it so much that the walls of the former are pressed flatly together at the ventral surface. In the contracted condition of the worm, as after immersion in spirit, the communication between the œsophageal and the succeeding portion of the digestive system is almost obliterated.

c. *Alimentary Cavity Proper.*

The second or great division of the alimentary tube extends from the point of inflection previously mentioned to the posterior end of the worm, in the form of a ciliated chamber with glandular and sacculated walls; but the cilia, with the exception of a streak near the tip of the tail, are only well seen on making a transverse section of the living animal, though they are actually longer and more active than those on the cuticular surface. In pale species, such as *Lineus lacteus*, Mont. MS., the digestive canal is very distinctly divided, for the posterior region is not only more opaque than the œsophageal, on account of the greater development of its glandular elements, but its borders are crenate from the sacculations. The posterior aperture or anus is situated slightly in front of the tip of the tail, and is well guarded by the muscular structures surrounding it, as may be observed before granular matter escapes, for it requires the impulse of numerous waves of fluid before yielding under pressure. In some favourable specimens (Plate XIX, fig. 6) masses of cells and débris may be seen revolving within the dilated anus before extrusion. In various examples a distinct anal papilla (Plate XVII, fig. 22), furnished with a tuft of longer cilia, projects posteriorly.

In transverse section (Plate XXI, fig. 1), the encroachment made on the cavity by the ovaries, during the period of their activity, is well shown, and also the gregariniform parasites, which often occur so abundantly in these worms. When the animal, after spawning, has regained condition in its native haunts, the granular cells of the digestive chamber become largely developed, so that in transverse section the body is rounded (Plate XX, fig. 3), and the entire middle region filled up by the mass, with the exception of an irregular fissure in the centre; whereas considerable atrophy of these elements occurs during long confinement, or the exigencies of reproduction. Towards the posterior end of the worm the tract is much diminished, and, in the living animal, more evidently ciliated when viewed from above. The minute structure of the wall of the cavity (Plate XVIII, fig. 16) bears much resemblance under pressure to that of the ciliated œsophageal region in *Amphiporus,* having a basement-substance, in which are imbedded a vast array of granular glands, and with the inner surface richly ciliated. The contents of the glands (Plate XXI, fig. 7) consist of granular cells and globules, which readily escape from the free border of the organ, and are often ejected per anum.

In *Carinella* and *Valencinia* this and the previous region agree so closely with the arrangement in *Lineus* that no special description is necessary.

The ciliation of the entire digestive canal is more apparent in *Cephalothrix linearis* than in *Lineus.* It has a similar arrangement in transverse section (Plate XXI, fig. 2), and the same gregariniform parasites and an *Opalina* occur. In structure the first or œsophageal portion has a much more lax and cellular aspect than the succeeding densely granular region; and from the translucency of the animal the distinctions between the divisions are more exaggerated. In one specimen sent from St. Andrews in April, the digestive chamber was coloured of a fine pea-green (Plate IV, fig. 5), instead of the usual pale pinkish hue, a state due to the uniform tinting of the cellular elements, it may be from the nature of the food, such as the deep-green ova of *Phyllodoce.*

Ehrenberg, De Quatrefages, Girard, and Stimpson considered the mouth to be the genital orifice, the former observing that a large quantity of mucus was discharged therefrom. Mr. H. Goodsir thought the canal common to the respiratory, digestive, and generative systems. "In *Serpentaria,*" he observes, "it acts almost as an organ of digestion, while in Nemertes there is a trumpet-shaped exsertile proboscis, which, contrary to the opinion of Rathke and other naturalists, and according to the opinion already expressed by Ehrenberg, is the intestinal canal." He agreed with Ehrenberg in supposing the ova escaped into this chamber. His views were rather erroneous, such as imagining the first region of these worms to be composed of a single annulus; but the succeeding or terminal of many, each about an $\frac{1}{8}$th of an inch in length; moreover, that each of the separate annuli contained all the elements of the perfect or original animal, viz., a male and female generative apparatus, the cavity common to the generative, digestive, and respiratory functions, and a small dorsal vessel analogous to the intestinal canal of Nemertes. *Serpentaria,* therefore, he explains, "is a composite animal, each perfect individual consisting of numerous and apparently still unformed or imperfectly formed individuals." Modern researches do not support any of these suppositions. Amongst the British zoologists who have examined these animals, Dr. Williams, while admitting the digestive nature of this chamber, misinterprets its true relations. He considers the organ a closed sac filled with a milky fluid, and having many diverticula, into which the nutritive matter passes by exudation from the proboscis. He appears thus to have drawn up his description from one of the Enopla, which possessed no large slit leading into the chamber. He denies the existence of a proper anus. While thus deviating from the true structure of the parts, he is correct at least in viewing the chamber as digestive, and quite independent of the generative system placed to its exterior.

Sir J. G. Dalyell, whose untiring scrutiny of the habits of such animals is worthy of all praise, saw a *Lineus* (his *Gordius gesserensis*) feeding by the ventral slit, which he therefore correctly termed the mouth. Dr. Johnston in his 'Catalogue' observes:—"There is another and much larger aperture in front, behind and underneath the head. Long mistaken for the mouth, this has been usually described of late as genital, but the orifice is doubtful." He terms the alimentary canal the general cavity of the body. M. van Beneden does not demonstrate that the so-called biliary elements are simply constituents of the wall of the digestive cavity, and not special cæca attached to the sides of the canal. In *Lineus bilineatus* (his *Cerebratulus Œrstedii*) he states that the nutritive chamber is divided into three compartments—the first short, and corresponding to the œsophagus; the second twice or thrice the length of the former, and representing the stomach; the third extending to the posterior extremity of the worm and constricted at regular intervals, and equivalent to the intestine. I have not yet noticed this in the British examples, which agree with the typical *Lineidæ* in the structure of the organ, although the external aperture or mouth is somewhat smaller. Prof. Keferstein's description of the cavity as applied to *Lineus*, though brief, is good, and his criticism of Van Beneden's view, in regard to the "liver" in the same group, fair.

7. *Nervous System.*

The cephalic ganglia or central organs form two large and conspicuous pale red masses situated a short distance behind the snout of the worm (Plate XIX, fig. 1). They differ in shape, as seen under slight pressure, from the same organs in the Enopla, each half being narrower and more elongated, so as to cause the entire arrangement to have the appearance of a horseshoe-magnet. In some specimens, instead of being more deeply tinted than the rest of the cephalic tissues, they are paler, on account of the deep red coloration of the latter; while in others they can scarcely be distinguished under the dense blackish-green coating of cutaneous pigment. They are surrounded by the usual fibres of the region, besides the proper sheath of the ganglia. The inferior commissure, often of a deep red hue, is well marked, and placed quite at the front. The curves of the ganglia do not bulge so much forward on each side as in the Enopla, and thus the anterior margin of the system forms a nearly uniform transverse line. The superior commissure is smaller and less distinct; indeed, it is with difficulty seen in the living animal as a transparent preparation. Each ganglion is composed of a superior and an inferior lobe; and in minute structure the nervous matter agrees with that in the Enopla. The inferior lobes and commissure rest upon the solid tissues of the snout (Plate XVIII, fig. 9) instead of having the buccal cavity beneath them, as in the latter. On making a transverse section of the ganglionic mass just behind the commissures (Plate XXII, fig. 1), the superior lobe is found to be more rounded than the inferior, and to communicate with its fellow of the opposite side by the superior commissure. The inferior lobes are somewhat ovoid, connected by the great commissure, and give off the lateral nerve-trunks posteriorly. In front the two lobes are soldered together, but towards the posterior part a section is now and then found, which shows the posterior end of the upper lobe separated from the inferior. This severance of the end of the upper lobe is not to be confounded with the free rounded sac which lies close behind, as demonstrated by a section in which the knife has cut the left ganglion somewhat further back than the right, and so indicated this separation on that side. The presence of the trumpet-shaped mouths of the ducts of the cephalic sacs in such a preparation shows that these bodies are posterior and not yet reached by the instrument. Longitudinal sections of the head of the worm exhibit the positions of the ganglia and the cephalic sacs with great clearness, each of the former often presenting different appearances on the respective sides from obliquity of section, but the posterior borders are always distinctly separated from the sacs (Plate XVIII, fig. 10).

In all sections of the ganglia a peculiar change occurs after mounting in chloride of calcium, the oily matter of the tissue collecting in curious streaks and circles, and apparently at some parts resisting the penetration of the fluid.

Considerable difficulty is experienced in making out the anterior branches of the ganglia, from the opacity of the snout; but three or four trunks of note are occasionally apparent—two large branches superiorly, and one or two smaller beneath. Some twigs seemed to proceed in the direction of the eye-specks, but their ultimate distribution could not be traced.

Each great nerve-trunk (Plate XIX, fig. 1, *n*) leaves the posterior end of the inferior lobe as in the Enopla, proceeds along the side of the body, and terminates at the tip of the tail. The calibre of the cords slightly diminishes as they course backwards; and their position is nearer the ventral than the dorsal surface. Branches probably exist, but only faint traces of such are seen in the longitudinal sections, for the opacity of the textures in the living animal prevents their being satisfactorily made out. The trunks are imbedded in a fibro-granular matrix (Plate XXI, fig. 6, *n'*) of the same reddish hue, and have, in addition, the proper sheath (*neurilemma*) of the nerve. In some pale species they are marked externally as two pinkish dorsal streaks. These trunks, as already indicated, have a very different position from the nerves in the Enopla, being situated outside the circular muscular layer, and between it and the great longitudinal. Two muscular coats (circular and internal longitudinal) thus intervene between the nerves and the body-cavity and its contents, whereas in the Enopla the nerves are within all the muscular layers.

The general arrangement of the cephalic ganglia in *Carinella annulata* agrees with that in *Lineus*, so that a special description is unnecessary. The lateral nerve-trunks lie between the basement-layer and the external (circular) muscular coat of the body-wall (Plate XXII, fig. 2, *n*). In *Valencinia lineformis* a variation is observed, since the nerves do not quite reach the external border of the great longitudinal muscular layer.

The chief peculiarity of the ganglia in *Cephalothrix* (Plate XIX, fig. 9), as first pointed out by Prof. Keferstein, is the advance of the almond-shaped upper lobes, so that the superior commissure is quite in front of the inferior. The lateral nerves are placed between an isolated longitudinal fasciculus and the great longitudinal muscular coat of the worm (Plate XXI, fig. 2).

Mr. H. Goodsir criticises the description given by M. de Quatrefages of the nervous system in *Serpentaria* and *Nemertes*, and, like Œrsted, denies its existence altogether, averring that microscopically the so-called nerve-trunks show no nervous elements at all, but are the testicles of the worms. I fear, however, this worthy naturalist depended rather upon analogy than actual observation in this case. He accounts for the nervous fibres seen by Rathke (the first who correctly described the ganglia in *Lineus*) passing from the cephalic ganglia to the narrow slits on each side of the head, by supposing them to be seminal tubes on their way to the furrows (his seminal apertures). M. de Quatrefages confines his examinations chiefly to the ganglia of the Enopla. Frey and Leuckart, again, confound the cephalic sacs with the posterior part of the ganglia. M. van Beneden makes a curious remark in regard to his *Nemertes Quatrefagii*—viz., that the " collier œsophagien" is peculiar for its red colour, which hue, he says, is less marked in the other species of *Nemertes*. This colour, he explains, is not due, as believed for a long time, to the nerve-ganglia, but to the vessels which surround them, and it can easily be understood how the ganglia were confounded with the vascular trunks. Nothing akin to this has ever come under my observation, and the minute anatomy of the region is adverse to the view. Prof. Grube had previously made the same remark in describing *Nemertes purpurea*, Johnst, a species which (judging from the descriptions) seems to differ very materially from *Nemertes Neesii*, and is apparently one of the Anopla, but I have not yet seen any British representative. Prof. Keferstein is scarcely accurate in affirming that the ganglia in this group are larger than those of the Enopla. In his figure of the parts viewed from the dorsum (Taf. vii, fig. 1), the cephalic sacs are not discriminated

8. *Cephalic Fissures.*

On each side of the head in the majority of the Anopla is situated an extensive fissure (Plate XIX, fig. 1, and Plate XVIII, figs. 3, 8, 9, *b*), which commences as a shallow groove at the anterior border of the snout, and terminates, in the form of a reddish pit, somewhat abruptly, just beyond the entrance to the cephalic sac. A distinct constriction of the anterior region occurs behind the fissures in *Lineus gesserensis*, thus marking off the cephalic boundary. There is nothing special in the anatomy of these fissures, for they are formed by a simple extension of the cutaneous elements superiorly and inferiorly, as represented in the transverse section (Plate XVIII, fig. 9). Their entire surface is covered with very active cilia, which, as before mentioned, I have often seen cease abruptly, and again begin to play vigorously. The vapour of chloroform, if applied in sufficient quantity, causes them to stop entirely, but they again commence vibration on the partial recovery of the animal. Œrsted and others have considered that these fissures perform a respiratory function, but of this there is no sound evidence. Mr. H. Goodsir thought they were the apertures of the male generative system, a supposition, as mentioned, scarcely requiring refutation. Prof. Keferstein gives a very good summary of the views of previous observers, but, while agreeing with none, he advances no new interpretation of these structures. He concludes by criticising M. van Beneden's statements, to which he objects, but he has scarcely reviewed them at sufficient length. M. van Beneden observes that the cephalic fissures are furnished posteriorly with a pit leading into a ciliated funnel, and that the lateral vessels when they approach the ganglia swell out into vesicles (" ils se renflent là en vesicules"), which simulate the ganglia, and convey their contents to the exterior by the ciliated funnel just mentioned. He considers that the central point of this apparatus lies immediately beneath the ganglia on each side; and he has seen, under compression, the pit of the lateral slit adjoin a large canal, which terminates exteriorly by a sort of funnel, and this leads into a pouch behind the nerve-ganglia. He did not see any vibratile movement within the vesicle; and states his conviction that this apparatus is similar to that in the Trematoda and Cestoidea. Thus, as Prof. Keferstein says, he has nearly retrograded to the time of Huschke, who thought these fissures connected with the lateral nerves, which he took for canals. In his enlarged figure, however, he represents the position of the cephalic sacs fairly, but he has a large blood-vessel running exterior to the nerves, and extending to the tip of the snout; this, of course, is at variance with a true interpretation of the structures in the Anopla.

The cephalic fissures, as characteristic of the typical *Lineidæ*, are absent in *Carinella annulata*, their places being supplied by two pale curved grooves on the dorsal and two continuous transverse furrows on the ventral surface of the snout. The depressions are richly ciliated. In the remarkable form from Balta, the snout is surmounted by two curious frilled processes (Plate XXI, fig. 9, *b*), which terminate posteriorly in a long filament. Whether the latter, however, is a structure *sui generis*, or only some normal constituent of the body (such as a nerve) in a peculiar position, the state of the specimen forbids our determining.

The cephalic fissures and furrows are entirely absent in the family *Cephalothricidæ*.

9. *Cephalic Sacs.*

At the posterior end of each lateral fissure, a funnel-shaped tube (*m'*, Plate XIX, fig. 1) leads into a large globular structure (*m*), often of a pinkish or reddish hue, and the apparent homologue of the cephalic sac in the Enopla. The globular body lies over the origin of the great nerve-trunk on each side, and abuts so closely on the posterior prominence of the upper lobe of the ganglion, as to have led some observers into the error of supposing it only a continuation of the ganglionic texture. Very careful preparations and examinations of the adult animal, as well as observations on the young at various stages, remove all doubt on this subject, and show that these globular structures belong neither to the nervous nor the circulatory system. The funnel-shaped duct (*m'*) is richly ciliated, and the cilia may be traced to the sac, wherein they are continued as a linear streak along its outer border, but its general mass is not furnished with these organs. The ciliated curve along the external margin is well seen in young specimens, but its exact superficial extent is difficult to determine. In favourable examples the walls are observed to contain finely granular cells, which have a clear and distinct nucleus. These cells are most evident on the inner and posterior curves, the outer curve being pale. The sacs project posteriorly into two large cavities—continuations of those indicated in Plate XX, fig. 1, *s*, *s*, on each side of the proboscidian tunnel, and are thus laved by the circulating fluid, which rushes forward from the walls of the digestive cavity; but there is nothing to support M. van Beneden's views as to their continuity with the circulatory system. Their relations to the ganglia have been adverted to already, and are well shown in some horizontal sections, where one sac has been severed considerably lower than the other.

Just in front of the external border of the curved dorsal groove on the snout of *Carinella annulata* (Plate XVII, fig. 24) is an ovoid body apparently homologous with the foregoing, but I have not yet been able to trace its anatomy, on account of the opacity of the cutaneous tissues in this animal.

The sacs are absent in *Cephalothrix*.

The function of these bodies may be excretory. Their gradual advance in position, and proportional diminution in size in the developing animal, are interesting features in this respect. Prof. Keferstein does not enter into structural detail with regard to these organs in this group, but states that they lie at the posterior end of the lateral fissure. In *Lineus sanguineus* he mentions they are in connection with the under surface of the ganglia, whereas they are situated distinctly above the latter. In his figure no separation is made, and the dilated organ is confounded with the posterior part of the superior lobe of each ganglion, the duct or ciliated canal running beneath. The development of these sacs in the very young Nemertean inside the *Pylidium*, as recently narrated by E. Metschnikoff, confirms all our views of their relations.

10. *Eye-specks.*

These are simply masses of black pigment, arranged on the sides of the snout with greater or less regularity, and without any special optical structure. The textures of the head and nerve-fibres themselves are so unfavourable for observation that I have had difficulty in making out nerve-branches thereto. A more definite structure is observed in the Enopla, both as regards nervous elements and complexity of organization. Some of the Anopla have no eyes (a remark, however, which does not apply to *Lineus marinus*), or have them only temporarily in their young state, like the Tornaria-larva of *Balanoglossus* or developing oysters and *Terebratulæ*, while all the known Enopla possess them. It is a curious fact that in transverse sections of the snout (such as Plate XVIII, fig. 7) considerable pigment-specks are seen towards the ventral surface.

11. *Vascular System.*

The circulation in *Lineus* diverges considerably from that in the Enopla, the vessels differing in definition, size, coiling, and contents. The main trunks, indeed, somewhat resemble long cavities, with contractile walls, within which floats a transparent fluid with corpuscles. I have termed this system the circulatory, but the current is driven by the contraction of the vessels now backward, now forward, so that it is rather a kind of oscillation.

There are three great longitudinal trunks—confining the description at present to the region behind the œsophageal division of the digestive tract—a dorsal (*p*) and two lateral or ventral, *r*, *r*, in the various transverse sections, and in Plate XIX, figs. 4 and 5. These three vessels in *Lineus* were first mentioned by Rathke. The dorsal is a large trunk situated immediately outside and to the ventral surface of the proboscidian sheath; while the ventral, also considerable trunks, lie on a lower plane, and nearer the middle line than the nerves. Indeed, when the three vessels are distended in *L. gesserensis* and *L. sanguineus*, they occupy almost the entire breadth of the worm under gentle pressure. They are frequently dilated in various ways, sometimes irregularly moniliform, crenate, or simply distended as long pale spaces. The three trunks are intimately connected by an array of simple and rather large transverse anastomosing branches (*y*, Plate XIX, fig. 4), some of which are forked. The transverse branches have special contractile walls, and are not mere random channels, as may be seen in the longitudinal sections of the worms (Plate XVIII, figs. 6, 4). They are subject to the various changes of form noted in the larger trunks. The great longitudinal vessels are further connected at the tip of the tail (Plate XIX, fig. 5). The dorsal generally contracts from behind forward, and drives the corpuscular fluid, not only to the front, but also through the transverse branches into the lateral trunks. The latter propel their contents in both directions.

At the posterior end of the œsophageal division of the alimentary canal the three great vessels, for the most part, lose their individuality, and, so far as I have observed, form an elaborate vascular meshwork between the œsophagus and the inner muscular layer of the body-wall (*u*, *u*, Plate XIX, fig. 1, and more clearly in Plate XX, fig. 2), again meeting in the lacunæ (*s*, *s*) in front of the cavity, and bathing the bulbs of the cephalic sacs which lie therein. These lacunæ or channels pass forward to unite at the ganglionic commissures, and the granules of the contained fluid may be seen rushing forward in the one and backward in the other. In addition to the smaller meshes surrounding the œsophageal region, there are two larger spaces on each side of the proboscidian sheath in transverse section, which may be held as the continuations of the dorsal vessel. The reticulations formed by this system are noticed under favourable conditions in the living animal (*e. g.* as represented in Plate XIX, fig. 1), as well as in numerous transverse sections. I have not been able to see any blood-vessel in the tissues of the head in *Lineus.* A distended pale portion may often be observed in the central line between the snout and the ganglionic commissures, as if the animal had gulped water by the aperture for the proboscis, so as to distend the channel, but this has no connection with the circulatory system. Transverse section demonstrates that there is no other channel in the snout in front of the ganglia than that just referred to.

In *Borlasia Elizabethæ* a reddish coloration is frequently observed in the living animal on the ventral surface at the white belts, showing that some contained fluid tints the dermal tissues during its passage. On puncturing the dilated anterior end, for example in removing the proboscis, a copious exudation of a reddish-brown fluid occurs. This presents many fusiform or clavate corpuscles, probably from the proboscidian fluid; but there are also present a vast number of minute granules of a yellowish colour by transmitted light (reddish in mass), which probably belong to the blood proper (Plate XVII, fig. 23). Many of the latter bodies show a contraction in the middle, so as to resemble a figure of eight.

In attenuate pale species, such as *Lineus lacteus*, Mont., MS., the intervention of an elongated region between the posterior end of the ganglia and the anterior border of the œsophageal region renders a special modification of the circulatory channels necessary. Accordingly, it is found that after the fluid collects in the spaces in front of the alimentary organ, it is conveyed by two long vessels forward to the ganglia, where the same ending occurs as in the other species. These channels seem to be simple elongations of the ordinary lacunæ, and are represented in transverse section in Plate XXII, fig. 3; thus forming an intermediate link between *Lineus gesserensis* and the still more extended post-ganglionic region in *Cephalothrix.*

In *Carinella annulata* two great longitudinal vascular trunks (Plate XXI, fig. 3, *r*) lie within the inner or longitudinal muscular coat opposite the nerve-trunks, and they are peculiar on account of their large size and the granular nature of their contained fluid. They form a coarse network in the œsophageal region, as in *Lineus*, and are continued forward just within the border of the snout to meet in a vascular arch.

In the fragmentary specimen from Balta transverse section of the anterior region (Plate XXII, fig. 2) shows a large ovoid and probably vascular tube (*r*) placed at the inner border of the great longitudinal muscular coat on each side, while the nerve-trunk (*n*) lies outside the latter. The cavity is partly filled in the preparation with minute granular cells. This agrees with the arrangement in *Carinella.*

Cephalothrix has also two great longitudinal vessels (Plate XXI, fig. 2, *r*) situated nearly opposite the nerve-trunks (*n*), from which they are separated by the chief longitudinal muscular coat. There is thus in this system also a deviation from the type of the *Lineidæ.* The size of the vessels is proportionally larger than in the latter, and their transparent fluid contains a number of minute corpuscles. In the living animal each lateral vessel contracts regularly and swiftly from before backwards, sending a wave of fluid towards its posterior end, at which the contraction ceases. A reversed movement by-and-by takes place, the contents being propelled towards the snout. Anteriorly the two vessels course forward by the side of the œsophageal portion of the alimentary canal without subdivision, pass along the sides of the proboscidian sheath in special cavities ($\bar{v}$), as in *Lineus lacteus,* in front of the former, and reach the ganglia, where they communicate. A junction has not actually been seen posteriorly, but analogy would lead us to suppose its existence. There appears to be little regularity or rhythm in the movement of the fluid in these vessels, both occasionally contracting from before backwards at the same time. Generally, however, the contractions are alternate.

Whatever special function the œsophageal region may perform in regard to digestion, it is clear the circulatory fluid bathing its outer wall is placed in a favourable condition for oxygenation, as the mouth now and then must give entrance and exit to sea-water, under the influence of the powerful ciliary currents caused by the entire surface of this division. Besides, it is evident that during the varied actions of the oral aperture (*e.g.* during feeding) the circulation would sometimes be much interfered with if such a *rete mirabile* did not exist. The special branchial apparatus in the homologous region of *Balanoglossus* (*vide postea*) also gives further weight to our interpretation of the structure of the parts in this group.

Dr. G. Johnston, Œrsted, and Dr. Williams mistook the ganglia for hearts, and the inferior commissure for a connecting vascular trunk. The blood, says the latter author, derived from the cutaneous system of capillaries, is poured by a dorsal vessel into one of the chambers of the heart (the dorsal). From the latter it is sent into the ventral cavity, and thence distributed over the integumentary and intestinal systems. He, moreover, says the blood is red, and always devoid of corpuscles. Such remarks are not based on correct observations. E. Blanchard in his examination of *Cerebratulus liguricus,* describes the nervous centres as lodged in a cavity into which the vascular trunks open, and this can only refer to the post-ganglionic lacunæ, though such do not by any means encircle the ganglia. I have not seen any vascular space surrounding the "trompe" in front of the commissures, as described and figured by this author; and the fluid of the proboscidian cavity could only have been noticed there during the ejection of the proboscis. He found numerous branches proceeding from the longitudinal trunks in his *Cerebratulus liguricus.* I cannot agree with M. van Beneden's views of the circulation in *Lineus,* for he describes the lateral vessels as swelling into vesicles when they approach the ganglia, their contents being conducted to the exterior by a ciliated funnel. The erroneous nature of this supposition has already been noticed under 'Cephalic sacs.' He also mentions that each lateral trunk communicates only with that of the opposite side posteriorly, and concludes doubtfully thus:—"Le long des parois du tube digestif, on voit en outre plusieurs vaisseaux, mais dont les aboutissants sont difficiles à découvrir." Another deviation from accuracy is apparent from his remark (under *Cerebratulus Œrstedii*) that "En arrière un gros vaisseau très-large, à parois très-contractiles, qui parait et disparait par intervalles, occupe la ligne médiane et semble s'ouvrir au bout de la queue." A reference to his figure and its explanation at once makes it apparent that he has mistaken the proboscidian sheath for a blood-vessel. Prof. Keferstein again does not enter into detail with regard to the circulation in *Lineus,* and his figures and descriptions apply to the Enopla, with two exceptions, which represent transverse sections of *Cerebratulus marginatus*. In that through the anterior part of the body five circular vessels at least are transversely cut in the meshes round the œsophageal region, and, moreover, they are joined by a pink band in the figure, apparently from a connecting trunk. I fear the author has been misled by the carmine used in the preparation, for in the British examples of " *Cerebratulus* " the arrangement characteristic of the *Lineidæ* is found.

12. Organs of Reproduction.

The sexes in the known *Lineidæ* are separate, and the ova and spermatozoa developed in their respective sacs between the inner muscular layer of the body and the digestive cavity. The glandular elements in the walls of the latter, indeed, undergo a certain amount of atrophy during the period of reproductive perfection (Plate XXI, fig. 1). Both ova and spermatozoa escape by pores a little above the lateral nerve-trunks, the apertures being frequently indicated by pale specks (Plate IV, fig. 2). In *Carinella annulata* they are often boldly marked by white spots (Plate VII, fig. 5). In this species also, as well as in *L. gesserensis* (Plate XVIII, fig. 11), the rudimentary condition of the generative organs may be seen in transverse section as a series of small globular or pyriform sacs, filled with granules and globules, and situated above the nerve-trunk on each side of the body.

a. Male Elements.

In *Lineus gesserensis* the spermatozoa (Plate XXI, fig. 10) have the aspect of slender rods, with a scarcely perceptible enlargement at the end from which the filiform tail proceeds. When a mass is taken from a living animal, groups often adhere to a point by one end, and, spreading in a radiating manner, lash the surrounding water with their tails. The spermatozoa of *L. sanguineus* (Plate XXI, fig. 11) are more minute than the former, and somewhat resemble an awl-handle in shape, with the filament projecting from the butt, which is thus frequently agitated, while the tapered end is comparatively still. In *Lineus marinus* the outline of the body of the spermatozoon (Plate XXI, fig. 12) is less regular than in the foregoing, and seems slightly crenate in some specimens. A very long filament is attached to the larger end. In *Micrura fasciolata* there is likewise a slight constriction in the middle of the spermatozoon, and the tail proceeds from the larger extremity. The reproductive elements were nearly perfected in the large Zetlandic variety of this form in August, the sperm-cells being filled with slightly curved rod-like bodies, having one end less tapered than the other.

b. Female Elements.

The ova occupy similar positions to those of the Enopla. They are few and large in *Lineus gesserensis*, smaller and more numerous in *L. sanguineus*.

13. *Mode of Deposition of the Ova.*

Instead of being deposited as free circular bodies, the ova in *Lineus gesserensis* are placed within a flask-shaped membrane, with one end narrowed to a fine point, and the whole enclosed in a tough covering of gelatinous mucus, which is fixed either to stone or glass, in the form of a bulky cord, as noticed by Œrsted. When a female specimen is about to spawn, she seeks the water-line, or a space above it, and quietly settles along the vessel. By-and-by a copious exudation of tough translucent mucus takes place, which envelopes the entire animal. In this mucus (Plate IV, fig. 3), which, when fresh, is crowded with small ovoid granular corpuscles from the cutis, the ova are deposited in flask-shaped capsules, each of the latter corresponding to an ovary, and containing all its ova, viz. from one to seven. Hence, by the nature of the parts, the ova are arranged in a somewhat irregular double row along each side, the extremities of the cord—corresponding on the one hand to the head and œsophageal portion of the digestive tract, and on the other to the extreme tip of the tail—being free from ova. In some instances the posterior end of the animal is curiously frilled and grooved on the ventral surface during deposition. When newly exuded the mucus is softer and less tenacious than it afterwards becomes, and the same may be said of the membranous flasks. The solidification of the mucus is analogous to what takes place, under similar circumstances, in the egg-capsules of certain mollusks, *e.g. Buccinum undatum.* If one end of the animal be disturbed from its original site on the glass before the ova are all deposited, four rows will be found instead of two, for sufficiently obvious reasons. The ova of *Lineus gesserensis* are of two shades, viz. white and pale brownish; and though the dark greenish examples often lay white eggs, they do not seem to do so always. Each ovum measures from $\frac{1}{70}$th to $\frac{1}{80}$th of an inch in diameter. The deposition takes place in January and February in those long confined; but some specimens sent from the rocks at St. Andrews towards the end of April likewise deposited ova, so that some latitude in regard to date is necessary. The American examples spawned in January, and those from Cuxhaven in March; but the *Nemertes communis* of M. van Beneden only did so in September. It is often observed that impure water causes recently captured animals to lay their ova rapidly, as if from a kind of abortion.

14. Development.

The development of the ova of *Borlasia obscura*—a species apparently identical with our *Lineus gesserensis*—has been described by E. Desor up to the period of the extrusion of the young from the capsules; and Max Schultze and Krohn have also investigated the subject, especially the former, so that I shall dwell only on such points as have not been elucidated. The British forms seem to offer great facilities for these investigations, and I have had no difficulty in rearing the *Lineidæ* a long distance from the sea.

The ova on deposition in the flask-shaped capsules (Plate XXIII, fig. 2) are uniformly granular and opaque; and when broken up, are found to be composed of a granular oily matter, which forms streaks and rounded masses, and is not cellular, as described by E. Desor. The clear, semi-transparent spot mentioned by the latter as occurring in the ova after deposition is seldom visible, though the germinal vesicle (*a*) and dot (*b*) are apparent enough in the centre of a pale oleaginous space, while yet in the body of the female (Plate XXIII, fig. 1). The flask enveloping them is composed of a fine hyaline membrane, that assumes many silky folds in the collapsed condition, and evidently contains a fluid which, with the semi-solid yolks, may be thrust out into the mucus. The cleavage of the vitellus generally commences on the second day, when in some it is found divided into two and in others into four parts (Plate XXIII, fig. 3). As first pointed out by Max Schultze, Desor was in error when he stated that the irregularity of the divisions of the vitellus distinguished this species from other animals. The divisions proceed regularly and somewhat rapidly; for ova which presented four lobes at 9 a.m. were found at 1 p.m. broken into a number of rounded masses, so that each had a nodular or mulberry-aspect (Plate XXIII, figs. 5 and 6). No clear spot is observed in the centre of the secondary masses (Plate XXIII, fig. 4). During the next four or five days the changes consist chiefly of subdivisions of the vitellus. There is now a pale spot in the ovum, and a few free granules and cells in the flask, as noticed by Desor. Each likewise assumes a smoother outline from subdivision of the vitellus, and only a few nodules appear here and there on the otherwise even circumference. E. Desor found the ova ciliated on the twelfth and fourteenth days, Max Schultze on the eleventh and twelfth, and I have struck the average amongst the British examples on the latter date. The ova, again, which had been left entirely above the water-line did not develop so quickly. At first the ciliation does not cause the mass to revolve, but subsequently this motion takes place with vigour (Plate XXIII, fig. 7). They continue in this condition about a month, and then a further change ensues in the contents of the flasks (Plate XXIII, fig. 8); and the latter drawing will explain E. Desor's discovery, as well as enable me to correct a slight inaccuracy into which he has fallen. The opaque ciliated mass previously noticed by-and-by shows a double outline under pressure, caused by the development of the young *Lineus* within the ciliated coating; indeed, at an advanced stage, as in the middle of the flask represented in Plate XXIII, fig. 8, the embryo seems to be shrouded in a layer of fatty cells and oil-globules (*b*), within which it distinctly moves. In such a condition the animal readily escapes from its investment, and at the upper part of the same flask a free example (*a*) is seen. E. Desor falls into a slight error in his excellent description, when he states that the cells in the interior of the embryo are the "residue of the vitellus destined for the support of the animal;" they are nothing else than the cells in the developing wall of the alimentary canal. The large dark ciliated mass (*c*) at the lower part of the flask, and the scattered cells and granules, are portions of the discarded external covering of the embryo; and it is to be observed that the cilia on this texture are somewhat longer than those on the free young animal, though their motion is less vigorous. The "cells" of which this rejected covering is made up are entirely of a fatty nature (Plate XXII, fig. 6)—in short, an aggregation of fatty granules, with an oil-globule or two, and capable of changing form accordingly. It is a fact that this débris after a time quite disappears from the flask, and therefore it probably acts as nourishment for the young (being swallowed by the mouth, as in the case of the embryo of *Purpura lapillus*) just as the yolk-sac, by a different mode, does in other animals. In escaping from the flask, the young animals, in many cases, seem to have thrust themselves along the narrow apex, dilating it and bursting through.[1] For a considerable time afterwards, both in captive and littoral cases, they crawl in swarms amongst the gelatinous mucus, so that the latter has a strange aspect,

[1] E. Desor makes the following remark about the young *Lineus*, when removed from the flask:—"It appears perfectly master of its movements, and on seeing it swimming about, and striking

being filled, in addition, with the transparent flasks from which they have escaped, and a few undeveloped ova. Moreover, it is a common practice for the adults to creep through these masses, and several are generally coiled in proximity. The number of undeveloped ova is extremely small, showing how easy it is to rear these animals, even with very limited supplies of sea-water.

The young *Linei*, at the stage previously mentioned, are visible to the naked eye as small elongated worms, somewhat tapered at the ends, pale, or rather translucent in front, and opaque-whitish posteriorly (Plate XXIII, fig. 9), while in structure they now closely approach the adult. The whole surface of the body is richly coated with cilia, which are especially active in the cephalic fissures, and still more so at the openings of the cephalic sacs. The ganglia are indicated by a pale space (*h*) on each side, but their actual outline is indistinct. There are in all cases at least two well-marked eyes. The cephalic sacs (*m*) are large and well defined, indeed very much larger proportionally than they are in the adult; and from their present position with respect to the ganglia, demonstrate the true form of the latter, as well as the error into which those authors have fallen who have confounded the sacs in the mature animals with posterior ganglionic enlargements. The sacs open by their ducts at the posterior part of the cephalic fissures (*b*), and the ciliary action can be traced inwards from these points. The œsophageal division (*j*) of the digestive canal is distinguished by its pallor, more evident ciliation, and the well-defined border of the succeeding opaque region (*j'*). The proboscis (*a*) is marked by a central streak of papillæ, and, after tapering posteriorly, curves forward, and disappears. The proboscidian sheath (*o*) is banded here and there anteriorly by transverse bridles; and a clear line is occasionally visible on each side of the opaque alimentary tube, as if from circulatory undulation. An anal papilla (Plate XVII, fig. 22), with a ciliated line connecting it with the digestive cavity, is also apparent.

Shortly after reaching the degree of advancement shown in Plate XXIII, fig. 9, the young *Linei* leave the gelatinous masses, and congregate at the water-line. Hundreds now perish from want of sufficient food, which in their native haunts is probably both abundant and suitable, while in the artificial circumstances and confined vessel it is denied them. Ten weeks afterwards the young animals are found still of the same whitish hue, and possess only two eyes, rarely an additional pigmentary fragment. The proboscis has much increased in size; indeed, at this time it has attained a comparatively larger development than the digestive cavity, which is in active use, since the young animal is entirely dependent on its own exertions for a supply of food. The œsophageal region is very distinctly marked, though its dimensions are proportionally small when contrasted with the length of the head; at present it is not a quarter the length of the latter, whereas in the adult it is several times longer. Its space is also considerably encroached on by the large cephalic sacs.

At a further stage of development the animal is much elongated (Plate XXIII, fig. 10), yet still possesses only two eyes. In this condition it has been mistaken for the representative of a different genus, and is probably that referred to by Dr. Johnston, under the name of *Cephalothrix* (*Vermiculus lineatus*, Dalyell).

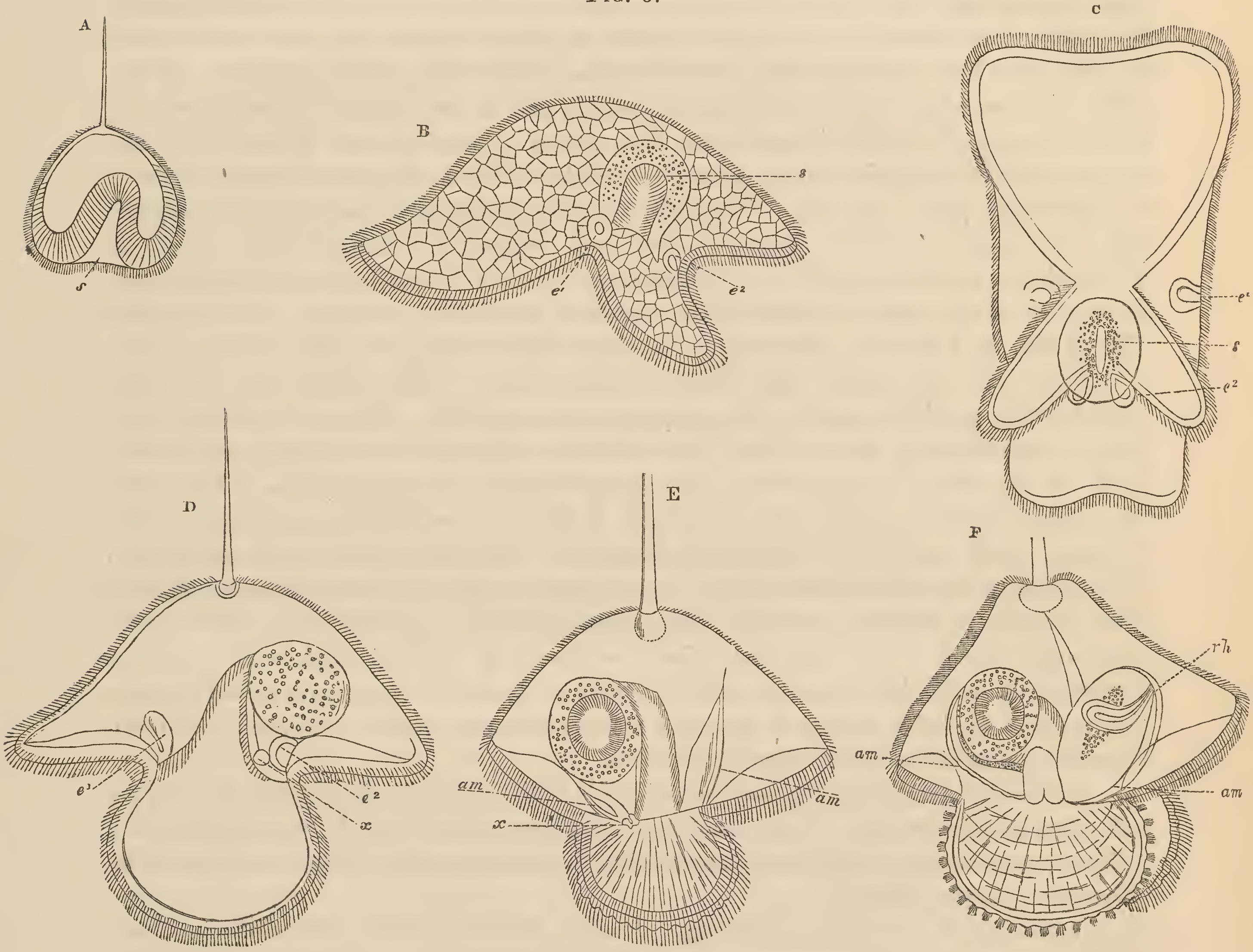
A vast cord of ova, about a foot long and half an inch in diameter, and which in all probability pertained to *Lineus marinus*, was brought from the deep-sea fishing off St. Andrews Bay about the end of June. The capsules are arranged in the gelatinous mucus in somewhat

against different objects, one might suppose it endowed with a certain amount of curiosity; sometimes, also, I saw them shake themselves convulsively, as if they had a chill."

indistinct transverse rows. Each ovoid flask (Plate XXIII, fig. 11) has a process as in *Lineus gesserensis,* but it is much smaller; and in the same manner contains several yolks. Unfortunately, from defective arrangements and the very hot weather, all the embryos were dead, only a little isolated ciliation being observed on certain cells. The embryos were furnished with black eye-specks.

In the remarkable development of the Nemertean from the *Pylidium*-form, as first described by Kröhn and the celebrated J. Müller, afterwards by Busch, Gegenbaur, Leuckart, and Pagenstecher, and recently by Metschnikoff, the phases mentioned in the foregoing pages are considerably increased in complexity. E. Metschnikoff finds that in the egg of a whitish *Lineus* from Messina the usual changes ensue after impregnation, resulting in the formation of a ciliated embryo, which by-and-by assumes the shape of a *Pylidium* (woodcut, fig. 6, A), having a depression of the

FIG. 6.

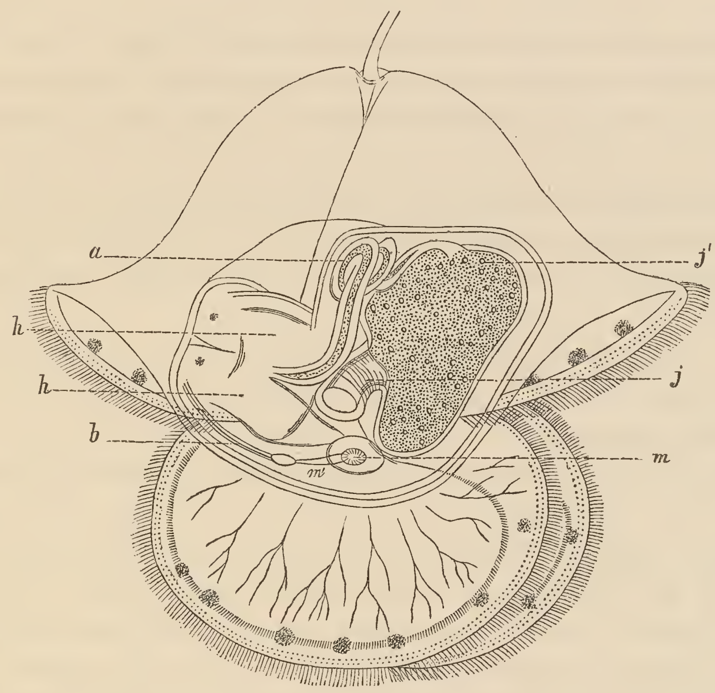


Pylidium-development. (After Dr. E. Metschnikoff.)

A.—Young *Pylidium* on its escape from the egg; *s*, the oral involution.
B.—Profile of a *Pylidium*, showing the early condition of the cæcal stomach (*s*), with its cellulo-granular coating; e^1 e^2, the anterior and posterior pair of processes from which the future Nemertean is developed.
C.—The same *Pylidium* viewed from the under surface.
D.—Profile of an older *Pylidium* with the processes developing, and after the appearance of the cephalic sacs (*x*).
E.—Another *Pylidium* showing the elongated leaves developed from the original processes, with the elementary amnion (*am*).
F.—A further stage in the process, the young Nemertean being now outlined; *rh*, the proboscis.

body corresponding to the mouth (*s*) and future digestive tract, and the usual long tuft of cilia. The involution is next differentiated into an œsophagus and cæcal stomach, the lining membrane being furnished with cilia and the wall with cellulo-granular elements (B). About this time the

Fig. 7.



Pylidium showing the young Nemertean and most of its internal organs.

Pylidium leaves the egg, and swims freely in the water. The second stage is the formation of the Nemertean in the interior of the *Pylidium*. The first step towards this end consists in the appearance of four round thickenings of the skin (B, C, e^1, e^2), two larger in front of the lobes of the helmet-like *Pylidium*, and two behind,—the four corresponding to the "suckers" of J. Müller. The anterior pair soon increase in size and become divided into a thicker and a thinner half, the former, moreover, making two folds. A "Seitenorgane" (*x*) (cephalic sac) appears in front of each of the posterior processes (e^2), which grow into two elongated vesicles, each with a thicker and a thinner portion. A commissure and the proboscis (*rh*) develop anteriorly, and other changes ensue both there and in the posterior processes; part of the latter investing the stomach, the thicker fold being directed towards the mouth of the *Pylidium*, while the thinner, coloured somewhat brownish, becomes converted into a very fine membrane, which forms a border to the thicker portion. These two processes (anterior and posterior), which are separated only by the utricle (Bläschen), become subsequently more closely arranged; so that the Nemertean embryo forms a semicircular mass. Further changes occur in the anterior and posterior processes, and the various parts of the Nemertean become differentiated. A membranous envelope, *am* (Amnion), is developed, in which currents are caused by the ciliated coating of the young worm. The ganglia, the ducts of the cephalic sacs, and a caudal style also appear, and the œsophagus and digestive sac assume a Nemertean type, the body of the young animal closing round the latter cavity. Finally, an almost complete young worm is found in the interior of its envelope (woodcut, fig. 7), and by-and-by it assumes a free existence. In the species described by Leuckart and Pagenstecher from Heligoland, no caudal styliform process was observed; but in J. Müller and Metschnikoff's forms this was present, and such may in all probability be the young of *Micrura fasciolata* (as mentioned by the former) or some other closely allied species.

E. Metschnikoff's summary of the development of the Nemertean in the *Pylidium* is as follows:—

1. The commencement of the Nemertean body is in the form of two pairs of cutaneous processes, which not only develop the body of the worm, but also the amnion.

2. Two median vesicles are produced, which at a later period become connected with lateral ducts.

3. The four structures developed from the cutaneous processes, which represent the future germ-fold, appear to be fashioned from two germ-leaves. From the outer leaf is formed the epidermis and central nervous system, from the inner the muscular coat (and perhaps also the circulatory system).

4. Through the coalescence of these four processes, primitive folds representing the future ventral surface, together with the head of the Nemertean, are developed; whilst the dorsal coverings are formed subsequently.

5. The proboscis is developed in the form of a simple process at the anterior part of the germ-streaks.

The reproductive organs of *Notospermus flaccidus* are correctly represented by Œrsted, but his drawing of the spermatozoa is inaccurate, since he shows a simple spindle-shaped body without a filament. M. de Quatrefages observes that the reproductive organs are digitate in *Borlasia angliæ*, and figures them after this manner; but such is scarcely a correct definition; neither have any cilia been detected in connection with these structures. Indeed, he has probably mistaken the digestive canal and its sacculations for the reproductive system, as he mentions that out of season the cæca are filled with a fluid more or less opaline. M. van Beneden found the ovisacs to contain from one to a hundred ova in his *Nemertes communis;* but though deposited in a membranous sheath in September, no change had ensued in November. His figure of the spermatozoa of this species is incomplete, as no tails are present, and he describes them as simple rods. He makes the interesting statement, that in the same animal he found the embryos in some ova covered with vibratile cilia even in the body of the parent, while others were only fecundated during or after deposition. The young Nemertean described by Dr. Busch, under the name *Alardus caudatus,* would seem to have some relation to *Micrura,* since it possesses a very distinct style at the posterior extremity.

Although I am not quite free from doubts concerning the exact position of the curious larval animal mentioned by Mr. Alex. Agassiz[1] as a further stage of the type first noted by the distinguished zoologist of Stockholm, Prof. Lovén, it may be well to conclude the present section by a few observations thereon. In the early stages it is a somewhat club-shaped animal, having a circlet of long cilia anteriorly, and another posteriorly in front of the anus. Behind the anterior ring of cilia, the mouth opens into an œsophagus, followed by a stomach and intestine. As the animal gets older two eyes and a pair of short cephalic tentacles appear, while the body becomes much elongated and distinctly segmented. At a further stage a remarkable retrograde metamorphosis ensues, whereby it loses the anterior and posterior ciliated rings, the tentacles, and

[1] 'Ann. Nat. Hist.,' 3rd ser., xix, p. 208.

the segmented condition of the body, and assumes the outline of a Nemertean, that is, has an elongated vermiform body without segments or appendages, a head furnished with two large eyes, and a mouth apparently opening behind the ganglia. The observations at present recorded, however, are not sufficiently decisive to satisfy us. Thus no mention is made of the important fact as to the presence of cilia on the general surface of the body, both before and after the shedding of the anterior and posterior circlets of long cilia. While it is true no bristles or other diagnostic structures connecting the form with the majority of the higher Annelids appear, it is equally evident that the essential Nemertean anatomy is wanting. Nothing is said of the characteristic cephalic ganglia and sacs, the lateral nerve-cords, the proboscis, or the structure of the cutis—points that are recognized in every known Nemertean long before it has reached the development and age of A. Agassiz's form. The latter thinks, also, that it approaches the *Nareda* of Stimpson, but this is doubtful, since the somewhat meagre description and the figure would indicate *Nareda superba* to belong to the division of the Enopla, whereas the young form has its mouth apparently opening behind the ganglia. Our judgment must therefore be reserved with regard to the particular type to which this interesting animal belongs.

The development of *Carinella* has not yet been observed.

In *Cephalothrix* the ova and spermatozoa are developed in a dense series of sacs (that give the animal a transversely barred aspect), which commence a short distance behind the mouth and continue nearly to the tip of the tail. The males are distinguished by their somewhat pale aspect when the reproductive organs are fully developed, viz. towards the end of January and during the subsequent months of spring. The spermatozoa (Plate XXI, fig. 13) consist of short flattened spindles with rounded instead of pointed ends, that to which the tail is attached being somewhat smaller than the other. In swimming the two ends appear as clear dots. Though the animal is extremely elongated, the bodies of the spermatozoa are comparatively short. The mature female presents a dusky or slightly fawn-coloured aspect, the ova, under gentle pressure in the living animal, being arranged in dense transverse rows in each ovary. The total number of ova produced by a single example must be very great. In transverse sections they occupy a large ovoid space on each side of the alimentary canal, upwards of twenty ova—very prettily arranged in a concentric manner—occurring in a single thin slice. The space of the digestive canal in these preparations had thus assumed the form of the letter *x*, the walls approaching each other in the middle, but diverging superiorly and inferiorly; while a wedge-shaped fold from the dorsum below the proboscis, and another from the ventral surface, completed the resemblance. This was the more marked if the proboscis had been ejected. The ova are deposited from the beginning of February till June; either adhering together in irregular masses by their edges or a little accidental mucus, or scattered about the vessel in detached groups. In several instances, however, they were enclosed in a translucent sheath of mucus. On deposition they have a granular structure throughout (Plate XXIII, fig. 12), with a clear spot and globule, and measure about $\frac{1}{180}$th of an inch in diameter. The ova pass rapidly through the usual stages, and on the 11th February the embryos revolve actively in the egg by aid of their cilia, and in some cases are hatched. The extruded animal (Plate XXIII, fig. 13), under moderate pressure, has a globular form, but assumes various shapes when free, the ordinary one being that of an apple—the long ciliary process representing the stalk, while the body slightly tapers towards the posterior end. It is opaque and granular, with the exception of the margin, which is somewhat translucent, from the slight differentiation of the cutaneous textures. Externally it is coated with long cilia, by aid of which it executes rapid motions, a tuft anteriorly having the form of a long whip-like process, and resembling a single mobile thread during the progress of the animal. The outline is sometimes pitted at the origin of the latter, while a slight papilla projects at the posterior end. When fixed between glasses the cilia are soon thrown off, and the body resolves itself into a number of cells and granules (Plate XXI, fig. 8). In two days the animal is somewhat elongated (Plate XXIII, fig. 14), and the mouth (*a*) is in the form of a strongly ciliated slit placed nearly in the centre of the body, which, with the above-mentioned exception, is still uniformly granular. A longer tuft of cilia at the anus is now more evident. Two days later considerable increase has occurred in the length of the body (Plate XXIII, fig. 15), and from the anterior position of the mouth, it is apparent the chief increment has taken place in the posterior region. The outline is now pear-shaped, the snout being much less tapered than the tail. The cutaneous textures are more distinctly marked, and the cells, with their refracting contents, very apparent; there is also a corresponding advance in the growth of the granules of the alimentary canal, its ciliation, and the posterior sacculations. The whip-like tuft on the snout is somewhat shorter, and there now exist a few longer cilia on the side of the head, the posterior group of which (*c*) are evidently the precursors of the long ciliary tuft, which by-and-by appears. There is yet no trace of eye-specks. A few cylindrical papillæ are observed on the snout and tail, and one or two along the sides, which processes do not seem to result from pressure. A day or two afterwards some are furnished with one and others with two eye-specks; moreover, the tuft of cilia on the snout is gradually diminishing, while the lateral cilia (*c*) before mentioned are becoming longer. During a period stretching from March to the beginning of June, the various vessels swarmed with successive broods of young (from different individuals), which in the form of minute white specks darted about most actively. They did not crawl along the bottom, but, like the young of *Phyllodoce* and other Annelids, swam freely throughout the water after the manner of *Infusoria*, or danced to and fro like *Ephemeræ* in the air. Externally at this further stage of advancement they still have a coating of very long cilia (Plate XXIII, fig. 16), which serve as natatory organs, the tuft (*c*) on each side being about thrice as long as the rest, while the anterior whip has disappeared. There are two large well-defined black eyes, no doubt provided by nature for the exigencies of the youthful state, just as the young of certain mollusks and cirripedes are similarly furnished. The mouth (*a*), the œsophagus, and succeeding region of the digestive cavity are all richly ciliated. The whole animal is soft and delicate, and few of my specimens survived this stage. Those which outlived the others became more elongated, and had a little reddish pigment developed in the snout. After the disappearance of the eyes (in October) they have the form of slender reddish bodies, with a conspicuous mouth a short distance behind the anterior margin. The cilia on the snout are very much longer than on the rest of the body, and project like a long brush or fan, so as to give the animal the aspect of an infusorial animalcule.

We have thus in *Cephalothrix* a certain resemblance to the development of M. van Beneden's *Nemertes carcinophila*, already described (see p. 93), and the phases of the growth of the present species likewise corroborate everything that has been advanced in contradistinction to the interpretations of the Belgian author. His views in regard to the *scolex* and *proglottis* receive no support from the foregoing observations, for all the changes that occur are only the gradual and very perceptible shedding of certain cilia, and the general advance in organization as shown by the differentiation of tissues and the appearance of pigment in the eye-specks. The moulting of the long anterior tuft of cilia by the young *Cephalothrix* has its analogue in the loss of the ciliated ring by the young *Phyllodoce* and others, in the shedding of the temporary bristles noticed by Busch and Leuckart in the young of a *Nerine*, and by M. de Quatrefages in the young stages of *Hermella*. I think there can be no doubt that the remarkable tuft of cilia occurring in the young *Cephalothrix* on each side of the snout, and which attains its full development after the long anterior whip has ceased to be conspicuous, is connected homologically with the entrance to the cephalic sacs in the Enopla, and the fissures of the *Lineidæ*, as well as with the ciliated ring of *Phyllodoce* above mentioned. It is an embryonic type of a structure which disappears entirely in the adult. The delicacy of the young at the period of the full development of the eye-specks is an interesting feature; but it prevented my observing their growth into perfect animals.

Thus, so far as development goes, *Cephalothrix* is nearly allied to the Enopla, especially to *Tetrastemma dorsalis*, *Nemertes carcinophila*, and probably to others of the group not yet investigated; while, in the structure of its digestive system, circulatory apparatus, and the unarmed proboscis with its bridled sheath, it leans rather towards the *Lineidæ*. Prof. Keferstein in his proposed classification of the Order rightly places the genus in a special Family, called *Gymnocephalidæ*, the chief characteristics described by him being:—Absence of cephalic fissures; brain like that of *Polia* (*Amphiporus*), but the superior ganglion covers the inferior much less, and is advanced in front of it. He bases his statement of the relationship to the Enopla, as it appears to me, on somewhat questionable grounds, for the ganglia are by no means closely allied in form and structure to those of that group.

III.—Reproduction of Lost Parts.

In the Nemerteans, as in the Annelida proper, the reproduction of rejected parts and the repair of wounds take place with accuracy and considerable rapidity. If but a fragment is left behind the head, a new body and tail are reproduced in the majority. The severed posterior half of the animal, or other headless fragment, seldom perfects a head in confinement, but remains alive for a year or more, slowly turning round when irritated, and, moreover, developing the generative products in its interior. Thus a specimen of *Lineus marinus*, sent from St. Andrews in September, broke into pieces on the journey; yet six months afterwards most of the fragments were alive, although the sea-water had not been changed more than once. The head and anterior portion of the worm, which at first scarcely measured two inches, had now grown a body and tail that when progressing extended at least seven inches, and of course was capable of much greater elongation, so that it looked like an independent animal; and this was accomplished without the aid of any food, except perhaps what it might have acquired from the fragments of its own body in the neighbourhood. Some of the latter measured about a foot in length, and all were coiled in various ways, with the ends puckered, and in most cases fixed by a whitish cicatrix, which was firmer at one end than the other, and occasionally tapered. One of the most interesting features was the gradual development and elaboration of the products of the generative organs (in this case the male elements) in the headless fragments, so that when in February they were placed in clean sea-water, some gave exit to milky clouds of perfect spermatozoa. This would seem in these animals to be the main aim of such a provision, since their very length and softness, if not fragility, apparently court disseverance. They display greater vitality in this respect than the majority of the Annelida, and it is not necessary that the sea-water be changed for years, or that fragments of their own bodies or other débris be present. In one species, moreover, each of the numerous fragments into which its lengthened and fragile body breaks becomes a perfect animal.

In captivity, specimens of *Lineus sanguineus* (Plate V, fig. 2) have often a great tendency to rupture into many pieces. These fragments lie on the bottom of the vessel, and, in the majority, consist of the body-wall, its nerve-cords and vessels, the central alimentary chamber, and the dorsal sheath for the proboscis. Numerous parasitic gregariniform bodies, as well as the peculiar ova to be described subsequently,[1] may also be seen in them; and the new animals are thus supplied, *ab initio*, with such structures in their digestive tracts, without being subjected to the earlier stages in their development. For some time after separation the large aperture of the digestive chamber existing at each end remains closed by firm contraction of the circular muscular fibres of the body-wall; but by-and-by new cell-growth occurs at both extremities, especially the anterior. At the latter the parts firmly contracted by the primary muscular spasm gradually become more or less consolidated by a cicatrix. This new growth steadily increases in bulk, distinguishing the anterior end of the fragment, even in the early stages, by its conspicuous pallor. The appearance of this extremity in a specimen, probably about three weeks after rupture, is shown in Plate XXII, fig. 7. The head is represented by the pale, sprouting mass in front of the alimentary tract, and there is no further differentiation of organs than the separation of the exterior (cutaneous) elements from the inner mass, and the ciliated aperture (*a*) leading into the sheath for the proboscis. The three contractile circulatory channels of the body course forward to the pale developing region, and apparently communicate with each other without passing into it; they are connected by the usual transverse branches throughout their course. The posterior end of the fragment shoots into a conical tail (Plate XXII, fig. 8), with a well-formed anus (*z*) in its proper position, and through which, under pressure, a prolapsus of the wall of the digestive chamber occasionally occurs, or an escape of one or more gregariniform parasites.

In the next stage (Plate XXII, fig. 9) the anterior end has assumed a more conical form, and there is a greater differentiation of organs. The cutaneous elements are distinctly marked, and a miniature proboscis (*a'*) occupies its sheath, both springing from a point some distance behind the tip of the snout, and corresponding to the commissure of the developing ganglia (*h*), which latter, however, are scarcely apparent. The proboscidian sheath contains a clear fluid and granules, which now and then distend the front as in the figure. The proboscis (*a'*) is quite free posteriorly. The cephalic fissures are indicated on each side by slight superficial grooves, very strongly ciliated. Besides the faint contour of the ganglia, which spring from the anterior ends of the nerve-trunks, the cephalic pits and glands (*m*) are outlined. The circulation in the vessels extends only to the posterior border of the white snout. The digestive tract presents no subdivision into regions.

[1] See also 'Journ. of Micros. Science,' 1867, "Trans. Micros. Soc.," p. 40.

A more advanced condition of the head is found after two or three months (Plate XXII, fig. 10). The snout is very much elongated both before and behind the commissures. In some eye-specks now appear in their usual position, and there is a distinct channel leading inwards to the enlarged proboscis; the ganglia approach the normal shape, and the cephalic pits, with their ducts passing into the posterior end of the cephalic fissures, are well marked. The anterior part of the alimentary tract has assumed a rounded form behind the ganglia, with the mouth (*w*) in the usual position. In those best developed (*e. g.* Plate XXII, fig. 11), the first or œsophageal division of the canal is differentiated from the succeeding portion; and in the ordinary fragments it is apparent that the former consists, for the most part, of new texture. Such examples, however, do not always possess eye-specks. The circulation now scarcely differs from that in the adult.

The motions of those with reproduced heads (Plate XXII, fig. 11) are not so active as usual in young *Linei*, and the animals are at once distinguished by the pointed nature and pallor of their snouts.

The formation of a complete individual, and the prolonged retention of certain functions by the headless fragments, under circumstances so adverse as the above, may give some idea of the powers of regeneration and vitality possessed by these worms in their native haunts; for it is to be remembered that they were at a great distance from the sea-coast, had no food (except what they might obtain from microscopic animals or the fragments of their own bodies), and had a very limited supply of salt water.

Moreover, besides the application of the ordinary laws of natural and sexual selection (if such exist in these forms), we have thus the additional (fissiparous) operation by which mere fragments of the body of the animal are capable of reproducing the entire organism and all its complex parts.

In like manner very serious wounds made in removing the proboscis are easily repaired, without leaving a trace of the injury after the pigment is fully developed in the cicatrix. Portions may also be removed from the posterior end of long species for microscopic purposes, while the rest of the animal lives and thrives for further observations.

The reproduction of the proboscis is referred to under the anatomy of that organ in the Enopla.

Comparatively few abnormalities of external form are met with in the Nemerteans. An example of *Lineus sanguineus*, found at Lochmaddy, had a curious diverticulum about the posterior end of the œsophageal region. This process was covered by all the coats of the body, and, in the preparation, contained a knuckle of the proboscis. The accompanying woodcut (fig. 8) represents the anterior part of the specimen during life.

Fig. 8.

Lineus sanguineus, with a diverticulum of the body. Somewhat enlarged.

IV.—Parasites.

A very common parasite in the Nemerteans is a *Gregarina*, which frequents the alimentary chamber of *Amphiporus lactifloreus*, according to Mr. Lankester, and is found abundantly in the same region of *Lineus gesserensis* and its allies. The presence of such animals in the Nemerteans appears to have been first noticed by Dr. G. Johnston, who in 1837 described them in *L. gesserensis* (with an accompanying figure) in the first volume of the 'Magazine of Zoology and Botany,' thus:—"When pressing a portion of the body between the plates of glass, I have occasionally seen some bodies escape, of a curved fusiform shape, acute at both ends, and marked with a pale circular spot. They have shown no signs of life, nor can I say what they are, though it has occurred to me that they may be the embryo-young; and that the worms may in fact be ovo-viviparous." This excellent naturalist thus misinterpreted their true character. Prof. Kölliker[1] in his contribution to the genus *Gregarina*, in 1848, more clearly defines their nature, and describes them under the name *Gregarina Nemertis*, from the alimentary canal of *Nemertes delineatus* (*Polia delineata*, D. Ch.). Frey and Leuckart, Max Schultze, Van Beneden, and other authors have also noticed their presence.

The *Gregarinæ* occur in swarms in many examples, and consist of elongated comma-shaped bodies (Plate XIX, figs. 10 and 11), having a transparent investment filled with minutely granular contents, and each has a large pale nucleus, measuring from $\frac{1}{1500}$th of an inch upwards, according to the size of the specimen. The nucleus shows faint markings when the parasite is first extruded, but a distinct nucleolus is not very apparent, though from the recent excellent observations of Ed. van Beneden,[2] it is probably present. In perfect specimens the snout is pale, very faintly granular (and quite diaphanous), bluntly rounded, and marked by a slight swelling of the body at its base, from which prominence the snout gently tapers. There is no trace of rough points or other apparatus for attachment. Sometimes, as when the investment has received injury, the surrounding water seems to pass inwards and separate at certain parts the contained granules from the sheath, a fact which shows a certain degree of cohesion in the contents *in sitú*, or the presence of another layer. A favourable opportunity of examining the parasites is occasionally afforded by the spontaneous rupture of some of the Nemerteans. The *Gregarinæ* then project from the granular parenchyma throughout their entire length, with the exception of the snout, by which they adhere. Indeed, this may often be seen in the perfect worm, for the waves of fluid bend hither and thither the free bodies of the parasites. After remaining for some time in the previously mentioned position (under pressure) a few separate themselves, and move through the salt water with a slow gliding motion like that of a diatome. On careful scrutiny the contour of the snout in a living specimen is observed now and then to vary. The motion of the body is not due to currents between the glasses, as it passes through mucus in the same manner. After remaining in salt water for eight or ten hours all movement ceases, and in some the body becomes club-shaped (Plate XIX, fig. 11); at the same time the clear portion at the snout is almost obliterated by encroachment of the granules. Occasionally one of the *Gregarinæ* is observed in a degenerating condition, forming an ovoid body in which the bent and atrophied parasite is scarcely distinguishable.

[1] 'Zeitsch. für wiss. Zool.,' Bd. I, pp. 1 and 2, Taf. I, fig. 4 *b*.

[2] 'Bullet. de l'Acad. Roy. de Belg.,' 2me sér., tome xxxi, No. 5, 1871. See also 'Quart. Jour. Micro. Sc.,' July, 1872, pp. 211 *et seq.*

The large number of the *Gregarinæ* in some examples of the Nemerteans must give them a position of importance in the economy of the worms. They likewise occur in the Planarians and in the true Annelids.

The small bodies shown in Plate XX, fig. 10, were extruded in multitudes with the *Gregarinæ* from *Lineus gesserensis* and *L. lacteus.* They were generally of an ovoid or pyriform shape—a few being circular, and contained many granules. Their diameter is about $\frac{1}{1000}$th of an inch, or rather more. They appear to be pseudo-navicellæ.

Accompanying the gregariniform parasites certain ova are sometimes ejected from the alimentary chamber, enveloped in mucus, and in the form of an elongated cordon (Plate XX, fig. 11), the latter being rather more than the breadth of two ova, which are loosely scattered in the slightly granular gelatinous matrix. These ova (Plate XX, fig. 12) measure about $\frac{1}{400}$th of an inch in diameter, and each contains an embryo that, for some time after the extrusion of the egg, makes very evident movements. They have two coats, and the embryo is finely granular, with a large pale nucleus. I have not seen the embryo hatched in a perfect state, but it is probable that these ova are connected either with the parasite of the muscles hereafter to be described, or with an unknown trematode-larva.

Another curious parasite is found burrowing in the body-wall of *Lineus gesserensis,* its presence being readily recognised by the perforated and honey-combed appearance of the dorsum of the affected animal, whose textures seem to be the seat of the workings of a microscopic *Tomicus typographus.* When highly magnified the affected region appears to be covered with a vast network of pale, minutely granular channels, which contain numerous opaque ovoid granular masses. On rupturing the body of the worm a large number of the peculiar structures (Plate XVIII, fig. 17) slide out of the channels, and swim through the surrounding water, generally, though not always, with the upper end (in the figure) first. Externally they are coated with long cilia, whose activity in the free state is of somewhat short duration, for after a time the animals remain quiet and they drop off. The body is distinctly segmented, and tapers slightly towards the posterior end; while the surface is marked by very fine longitudinal striæ, as in *Opalina,* though in a much more minute degree. Anteriorly is a conical portion (*a*), composed of three rather indistinctly marked segments. Two evident annuli (*b*) succeed, the posterior part of the last being narrowed, so as to cause a constriction of the body-wall. Behind are six nearly equal divisions (*c*), each often appearing double, that is, has a broad anterior and a narrow posterior annulus. The posterior region (*d*) consists of three indistinct segments. The body is minutely granular throughout, and an internal cavity is apparent from the fourth segment to the last, commencing in the former by a rounded end, and terminating just within the border of the latter. No aperture is observed at either end. The opaque ovoid granular bodies (Plate XVIII, fig. 18), scattered profusely throughout the infected portions of the *Lineus,* are evidently early stages in the development of this species, and they too are ciliated. On subjecting them to gentle pressure (fig. 19) transverse segmentation is apparent, the number of segments varying according to the degree of advancement. The parasites are very delicate structures, and in the free state soon break up into cells and granules, after discarding their cilia as above mentioned. Transverse section of the affected worms shows that they occur both in the skin and in the walls of the digestive tract, their ravages in the pigmentary layer of the former tissue causing the curious appearances which led to their detection. It is a somewhat difficult point to determine whether the skin, muscles of the body-wall, or digestive canal, constitute the common area of this creature's depredations; whether it is piercing the former on its way to the surface, or passing towards the alimentary cavity to be voided per anum. The characteristically segmented condition of the full-grown specimens, and their internal structure, exhibit a higher type of organization than the ordinary *Opalina*. Prof. Keferstein[1] found a very similar parasite in the stomach of *Leptoplana tremellaris*, but he did not describe it further than simply mention, under the explanation of the Plate, that it is an enigmatical structure. The centre of the body is occupied by a double row of large cells in his figure.

In the external longitudinal muscular layer and the region to the exterior in *Lineus marinus*, certain parasitic or adventitious cellular masses are found (*a*, Plate XXII, fig. 5). They lie in definite spaces (*b*), and consist of rounded cells filled with granules.

Another parasitic structure occurred in a large male specimen of *Amphiporus lactifloreus* in the shape of an oviform body enveloped in a granular lobulated mass, lying close behind the ganglion of one side (Plate XVII, fig. 11), to the exterior of the proboscidian sheath, and altogether unconnected with the œsophagus. Externally is a distinct hyaline capsule or cyst (γ), to which certain fragments of the fibro-granular lobulated covering adhere. The embryo (Plate XVII, fig. 12) is furnished with a very conspicuous opaque granular mass, and two discs; while the general stroma is cellulo-granular, here and there closely streaked by minute lines, apparently from its external investment. No motion of the included animal is observable, except an alteration in the size and aspect of the pores and discs after a period of eight or nine hours (Plate XVII, fig. 13). This is evidently a trematode-larva in its capsule, and by rupturing the latter a complete view of the embryo is obtained (Plate XVII, fig. 14). The oral sucker (*c*) is considerably smaller than the ventral (*b*). The œsophageal body (*d*) appears as a distinct swelling near the oral disc, and from the tube behind the former the alimentary cæca (*e*, *e*) branch off and become lost in the cellular tissues posteriorly. The opaque mass of cells and granules at *a* may be connected with the testicles, and the two circular granular bodies, *f* and *g*, are probably associated with the ovaries. A trace of the excretory tubes appears at the oral sucker.

In a specimen of *Cephalothrix filiformis* several examples of an *Opalina* occurred, but such on the whole seem rare in the Scottish Nemerteans.

V.—Classification.

As might have been expected in the case of animals whose anatomical structure was either unknown or much misunderstood, great diversity has prevailed in the classification of the Nemerteans. The early writers, such as O. F. Müller, O. Fabricius, and Gmelin generally placed them amongst the Helminths or intestinal worms (under the genus *Planaria*); and even Cuvier associated them with the same group. Others, such as Oken and Fleming, ranged them near *Gordius* and *Lumbricus*. De Blainville, again, established the family *Teretularia* for their reception, the title being founded on the external appearance of the animals. Ehrenberg next

[1] 'Der K. Gesellsch. der Wissensch. vorgelegt, am 4, Januar, 1868.'

constituted the class *Phytozoa Turbellaria* for them and the Planarians, as described in detail in the 'History.' Other authors, such as Quoy, Gaimard and Macleay, placed them under the group "Vers Apodes," without any definite basis of classification. Dr. G. Johnston first pointed out the important fact, that one group of the Nemerteans had and that the other had not stylets, and thus he has partly the credit of the classification promulgated by Max Schultze. They constituted, again, the *Annelosi Polici* of Delle Chiaje; and the fourth sub-order (Cestoidina) of the *Apoda* of Œrsted. Kölliker's division of the Nemerteans, according to the presence or absence of a sheath for the proboscis, rests upon a misunderstanding, as the sheath is present in all. De Quatrefages adopted Ehrenberg's classification with amendments, placing the Nemerteans under the third order *Miocœla,* and founding his subordinate groups on the position (lateral or sub-lateral) of the nerve-trunks, and the situation of the mouth. Von Siebold ranged them as the first order of his ringed worms (Apodes), and separated them from the Planarians by the intervention of the Rotatoria. Blanchard formed the term *Aplocœla* for the group, and thought the term Nemerteans should be restricted to a tribe or family, but the author was misled as regards the true alimentary organ. Diesing's arrangement is sufficiently alluded to in the Zoography, and rests on no secure basis. Girard wished to class them with the mollusks, an idea which found no other supporter. Max Schultze divided Ehrenberg's class Turbellaria into the sub-classes *Aprocta* and *Proctucha,* the Nemerteans being grouped under the latter. This author afterwards split the order Nemertinea into the *Enopla* and *Anopla,* according to the armed or unarmed condition of the proboscis. Stimpson's classification was based on the presence or absence of the ventral fissure, and other external characters, and therefore failed where it was most wanted. The same may be said of Schmarda's arrangement, where the characters of the sub-orders are founded on the "respiratory" fissures. Keferstein establishes the primary division of the order on the same basis as Max Schultze, but enters much more minutely into the subject. His families rest on characters derived from the fissures of the head and the arrangement of the ganglia. There is little new matter in the classification adopted in the Catalogue of the British Museum. In his 'Handbuch der Zoologie,' J. V. Carus arranges the Nemerteans as the first division (Turbellaria) of his fifth class (Platyelminthes) of the Vermes, the second division being formed by the Trematoda, to which he states the Planarians lead, and the third division by the Cestodes. Similar views prevail in several text-books of zoology.

The inquiry into the structure of the British Nemerteans rendered it apparent that considerable modifications of the existing schemes would be requisite, yet great care has been taken to interfere only where absolutely necessary.

With these brief remarks on the chief classifications already in existence, I may now proceed to explain the appended scheme.

CLASS TURBELLARIA.[1]

Order.	*Sub-Orders.*	*Families.*	*Sub-Families.*	*Genera.*
NEMERTINEA.	ENOPLA	AMPHIPORIDÆ	*Amphiporinæ*	I. Amphiporus.
				II. Tetrastemma.
				III. Prosorhochmus.
			Nemertinæ	IV. Nemertes.
	ANOPLA	LINEIDÆ		V. Lineus.
				VI. Borlasia.
				VII. Cerebratulus.
				VIII. Micrura.
				IX. Meckelia.
		CARINELLIDÆ		X. Carinella.
				XI. Valencinia.
		CEPHALOTHRICIDÆ		XII. Cephalothrix.

The characters of the order NEMERTINEA may be concisely described as follows:—Worms with more or less elongated, soft, ciliated bodies; nervous system composed of two conspicuous ganglia connected by a double commissure and two main lateral trunks; digestive system a ciliated canal with two apertures; circulatory system consisting of a series of closed contractile vessels. The proboscis forms the most typical organ in the group, is surrounded by a special muscular sheath, within which it glides in a corpuscular fluid, and passes in front between the commissures of the ganglia, while the digestive tract is placed inferiorly. Sexes separate in the majority, oviparous or ovo-viviparous.

The order may most naturally be divided into two great *sub-orders*, distinguished from each other by the presence or absence of stylets in the proboscis or typical organ of the group; the former being called after Max Schultze (but with amended characters) ENOPLA,[2] and the latter ANOPLA.[3]

The sub-order ENOPLA is characterised further by the globular and somewhat double nature of the nerve-ganglia, and by the fact that the lateral nerve-trunks are placed within the proper muscular walls of the body. The mouth, moreover, opens on the ventral surface of the snout in front of the commissures of the ganglia. The blood-vessels are more differentiated than in the ANOPLA. The young, so far as known, do not undergo any noteworthy metamorphosis in their growth.

In the ENOPLA there exist one great group and a subordinate one, which latter, however, retains so many of the characters of the former that it conveniently forms a sub-family. In the chief division (AMPHIPORINÆ) of the family AMPHIPORIDÆ the animals have two muscular layers in the body-wall, an external circular and an internal longitudinal; the proboscis is composed of three divisions, anterior, middle, and posterior, the former having in the typical species seven coats, viz. external elastic, external longitudinal, reticulated, inner longitudinal, circular, basement and

[1] *Turbella*, a little bustle or turmoil, referring to the ciliated integument of the animals.

[2] *η* and "Oπλα, arms.

[3] *α* and "Oπλα, without arms.

glandular layers. The middle region bears the stylets, and the posterior forms a long sac with two muscular coats, external circular and internal longitudinal. There are three great longitudinal vascular trunks, two lateral and one median, besides a cephalic arch. The cephalic sacs or glands are accompanied by long tubes or ducts. The animals as a whole have comparatively short and thick bodies, with proportionally large proboscides.

The sub-family Nemertinæ has the characters of the foregoing, with the exception of the last, since they possess more or less elongated bodies, and proportionally short proboscides.

It is right to mention that I have not been able to procure a specimen of *Prorhynchus*, but from the diminished size of the proboscis and other particulars, it would seem to follow closely on *Nemertes carcinophila*, Kölliker, one of the species in the previous sub-family.

The sub-order Anopla, again, is further distinguished by having the nerve-trunks generally placed between the muscular layers of the body-wall. The mouth opens on the ventral surface behind the commissures of the ganglia. The blood-vessels are somewhat less differentiated than in the Enopla. The young in the most conspicuous families undergo a remarkable metamorphosis.

This second sub-order has several families, the most typical of which is that of the Lineidæ, characterized by the more or less elongated shape of the ganglia (the arrangement with the commissures having the form of a horseshoe). The muscular covering of the body is composed of three layers, external longitudinal, circular, and internal longitudinal. The proboscis is furnished with five coats, viz. external elastic, external longitudinal and accessory band, circular, basement and glandular layers. The circulatory system consists of three great longitudinal trunks, two lateral and a dorsal, which frequently anastomose by transverse branches, form a *rete mirabile* in the œsophageal region, and unite in lacunæ behind the ganglia. The head has a deep lateral fissure on each side in connection with the cephalic sac, which is rounded, and devoid of long tubes or ducts posteriorly.

The curious specimen from Herm forms the type of a group that would perhaps require to be raised to the rank of a sub-family, but as no more than one specimen has yet been found, it is thought advisable to postpone this at present, and distinguish it only generically. In this animal the proboscis is extremely slender in proportion to the bulk of the body, and differs from the typical Lineidæ in having no accessory band cut from the longitudinal layer. Externally the organ has an elastic investment, then a longitudinal, a thin circular and a glandular coat. The reddish colour of the muscles of this species, and the tinted circulation, are likewise quite characteristic.

A more distinct sub-family of the *Lineidæ* than the foregoing, perhaps, might be formed by *Meckelia*, but for the present generic separation will suffice. The anatomy of the body-wall agrees with *Lineus*, but there are no cephalic fissures. The structure of the proboscis is also peculiar, for there is externally no distinct superficial layer, the outer coat consisting of spiral muscular fibres closely interwoven, within which lies a longitudinal layer, with the glandular coat on its inner surface.

The Carinellidæ are a very characteristic family. The general structure of the nervous system agrees with *Lineus*, but the lateral nerve-trunks are placed between the basement-layer and the circular (external) muscular coat of the body-wall, that is, quite without the two muscular layers in the typical form, and just within the circumference of the outer muscular layer in the other. There are no cephalic fissures. The circulatory system consists of two great lateral trunks. The proboscis has externally a double elastic layer, a thick longitudinal coat, and lastly, a glandular layer.

The family of the *Cephalothricidæ* deviates still more from the typical group. The arrangement of the ganglia differs, and the commissures are separated by a considerable antero-posterior interval. The lateral nerve-trunks lie between the longitudinal muscular coat and an isolated inner band of fibres having the same direction. The proboscis is supplied with acicular papillæ, and seems to have an external circular and internal longitudinal layer. The snout is devoid of fissures. The circulatory system is composed of two great longitudinal trunks, whose contents communicate behind the ganglia and at the tail. Oviparous; the young undergoing no distinct metamorphosis, though they have eyes, whereas the complete animal is generally eyeless.

VI.—SYNOPSIS OF FAMILIES, GENERA, AND SPECIES.

Order.—NEMERTINEA.

Sub-Order.—ENOPLA.

Proboscis furnished with stylets.

Fam. I. Amphiporidæ.—Ganglia rather rounded. Lateral nerves within the muscular layers of the body-wall. Mouth opening in front of the ganglionic commissures.

Sub-Family, AMPHIPORINÆ.

Proboscis proportionally large.

Genus I. Amphiporus, Ehrenberg.—Eyes more or less numerous, but never arranged in a square. Body rather short, sometimes flattened.

1. *A. lactifloreus,* Johnston.—Eyes grouped in two series on each side; body white, roseate, or greyish.

2. *A. pulcher,* Johnston.—Eyes well defined and numerous, irregularly grouped on each side. A central reserve-stylet in the proboscis. Cephalic furrows slightly branched.

3. *A. spectabilis,* De Quatrefages.—Head spathulate, peculiarly narrowed posteriorly. Eyes forming two long rows on each side. Cephalic furrows conspicuously branched. Longitudinally striped with brown on the dorsum.

4. *A. hastatus,* n. s.—Snout short and hastate, with a grooved dorsal ridge. Eyes indistinct. Brownish-yellow, with white grains on the snout.

5. *A. bioculatus,* n. s.—Snout acutely pointed, with a cephalic furrow—forming an angle directed forward on the dorsum—at its posterior boundary. Two eyes at the tip of the snout.

Genus II. TETRASTEMMA, Ehrenberg.—Eyes four; arranged so as to indicate a square or oblong.

1. *T. melanocephala*, Johnston.—A large black pigment-mass between the anterior and posterior pairs of eyes. Marginal stylet-sacs placed somewhat in advance of the central apparatus.
2. *T. Robertianæ*, n. s.—Head furnished with a brown collar, which sometimes hides the posterior (smaller) pair of eyes. Body longitudinally striped with two brown and a median white line.
3. *T. candida*, O. F. Müller.—Head flattened, wider than the rest of the body; eyes distinct. Stylets large. Pale yellow, greenish or reddish brown.
4. *T. vermicula*, De Quatrefages.—A longitudinal dark patch between (and connecting) the eyes of the respective sides.
5. *T. flavida*, Ehrenberg.—Head not wider than the rest of the body. Anterior and posterior pairs of eyes widely separated.
6. *T. dorsalis*, Abildgaard.—Body short, thick and rounded; speckled with yellow and brown; sometimes with a pale median stripe on the dorsum.

Genus III. PROSORHOCHMUS, Keferstein.—Eyes four; not forming a square. Snout dimpled and furnished with a transverse superior lobe. Ovo-viviparous.

1. *P. Claparedii*, Keferstein.—Snout blunt; eyes placed far back, the space between the anterior pair being widest. Yellowish.

Sub-Family, NEMERTINÆ.

Proboscis proportionally small.

Genus IV. NEMERTES, Cuvier.—Body more or less elongated, while the proboscis is very much diminished, the anterior region especially being shortened so as to cause the stylets to approach the ganglia.

1. *N. gracilis*, Johnston.—Eyes numerous. Snout broader than the rest of the body. Central stylet with a very long basal apparatus. Greenish or olive.
2. *N. Neesii*, Œrsted.—Eyes numerous. Stylets short and grooved. Streaked on the dorsum with purplish brown.
3. *N. carcinophila*, Kölliker.—Eyes two. No marginal stylet-sacs. Body pinkish.

Sub-Order.—ANOPLA.

Proboscis without stylets.

Family II. Lineidæ.—Ganglia elongated. Muscular layers of the body-wall three in number, viz. external longitudinal, circular, and internal longitudinal. Proboscis furnished with five coats, viz. external elastic, longitudinal and accessory bands, circular, basement and glandular layers. Snout with a deep lateral fissure on each side.

Genus V. *Lineus*, Sowerby.—Body more or less elongated, rounded or somewhat flattened, and tapered posteriorly. Head distinct, spathulate, and generally truncate in front. Eyes numerous, arranged along the sides of the snout anteriorly; rarely absent. Mouth in the form of a conspicuous longitudinal slit on the ventral surface. Other characters as in the Family.

1. *L. marinus*, Montagu.—Eyes numerous, deeply set in a marginal row on each side of the snout. Of a dull olive or blackish colour, more or less distinctly striped longitudinally.
2. *L. gesserensis*, O. F. Müller.—Eyes numerous, marginal. Snout distinctly wider than the rest of the body. Greenish-olive or reddish-brown.
3. *L. sanguineus*, Jens Rathke.—Eyes more regularly arranged than in the former; snout narrower. Body more elongated, and of a reddish or reddish-brown hue. Regenerates easily.
4. *L. lacteus*, Montagu, MS.—Snout similar to the foregoing, but the mouth is separated from the ganglia by a much longer interval. Body reddish anteriorly, pale posteriorly.
5. *L. bilineatus*, Delle Chiaje.—Snout rounded anteriorly; eyeless. Body of a pale brown or dull pinkish colour, with a white stripe on each side of a dorsal median line.

Genus VI. Borlasia, Oken.—Characters as in *Lineus*, but the proboscis is extremely slender, and has only four coats, viz. elastic, longitudinal, circular, and glandular.

1. *B. Elizabethæ*, n. s.—Snout pointed anteriorly; eyeless. Body generally contracted into a rugose mass posteriorly. Head pale, faintly streaked with greenish brown. Body marked with deep madder-brown.

Genus VII. Cerebratulus, Renier.—Body generally flattened, and thinned at the margins. Eyes in the usual position, but obscure. Proboscis with a cross of fibres at each pole in transverse section.

1. *C. angulatus*, O. F. Müller.—Snout somewhat pointed. Body much flattened; brownish.

Genus VIII. Micrura, Ehrenberg.—Characters as in *Lineus*, with the addition of a soft, filiform caudal process, capable of attachment.

1. *M. fusca*, n. s.—Eyes small, from four to eight on each side; body much flattened and thinned at the edges; caudal process often moniliform; colour pale brown or yellowish, speckled with brownish grains, especially in front.
2. *M. fasciolata*, Ehrenberg.—Eyes marginal, placed towards the anterior part of the snout; body various shades of brown, generally barred with white belts.
3. *M. purpurea*, Dalyell.—Eyeless. A bright yellow patch at the tip of the snout; body of a uniform rich dark brown colour.
4. *M. aurantiaca*, Grube.—Eyeless. A white patch at the tip of the snout; body rounded and of a fine brick-red hue.

Genus IX. Meckelia, Leuckart.—Structure of the rounded body-wall as in *Lineus*. Cephalic fissures absent. Proboscis furnished with only three coats, viz. external spiral, longitudinal, and glandular.

1. *M. asulcata*, n. s.—Eyeless. Body thick and round; of a uniform pinkish hue.

Family III. Carinellidæ.—Lateral nerves placed between the basement-layer of the cutis and the external (circular) muscular coat of the body-wall, or in the substance of the longitudinal layer close to the circular. There are only two muscular coats. The proboscis has four layers, viz. external elastic, circular, longitudinal and glandular.

Genus X. Carinella, Johnston.—Body elongated, tapering from the front backwards. Snout wider than the rest of the body, bluntly rounded in front; mouth sometimes small.

1. *C. annulata*, Montagu.—Eyeless, with a white patch on the snout; body round, of a rich red colour, striped longitudinally and banded across at somewhat regular intervals with white belts. Rarely pinkish throughout.
2. *C. linearis*, Montagu, MS.—Eyeless. Head spathulate, somewhat pointed in front; milk-white.

Genus XI. Valencinia, De Quatrefages.—Structure of the proboscis as in *Carinella*. The lateral nerves lie in the longitudinal muscular coat of the body-wall. The snout is shaped as in *Lineus lacteus*, and furnished with a row of eyes on each side. The mouth forms a distinct fissure a considerable distance behind the ganglia.

1. *Valencinia lineformis*, n. s.—Roseate in front, yellowish white posteriorly.

Family IV. Cephalothricidæ.—Commissures of the ganglia separated by a distinct antero-posterior interval. Lateral nerves placed between the longitudinal muscular coat and an isolated inner band of fibres. Proboscis has an external circular (or elastic), an internal longitudinal, and a glandular layer supplied with acicular papillæ.

Genus XII. Cephalothrix, Œrsted.—Head nearly cylindrical, slightly tapered in front; eyeless, or with a few obscure pigment-specks. Cephalic fissures and sacs absent.

1. *C. linearis,* Jens Rathke.—Body extremely attenuate. Of a pale yellowish or skin-colour, often with reddish grains towards the tip of the snout.

VII.—Homologies.

The majority of the early investigators of the Nemerteans correctly associated them with the Planarians, and generally linked them to the Intestinal worms, *Lumbrici,* or *Gordii,* as a single genus—*Planaria.* Other animals, however, which had no affinity either in form or structure, were grouped with them, often in a perplexing manner. Lamarck thought the Nemerteans approached the leeches, while Cuvier amalgamated them with his Entozoa. Ehrenberg, again, while he took the wise step of forming a class (*Turbellaria*) for them and the Planarians, does not seem to have had a very definite idea of their relationship to other animals, and, more especially, to other *Vermes.* This author's class appears to me to be a very natural one, and though a considerable hiatus exists between the Planarians and Nemerteans, as will afterwards be pointed out, the gap is very much less than that which separates the Turbellaria from the other groups of animals, and especially from the Trematoda. Delle Chiaje considered they had certain homologies with the leeches, on account of the structure of the "alimentary canal," but that in regard to the form of their bodies they approached the Planarians. Dugès, De Quatrefages, and Frey and Leuckart, were inclined to link on the Turbellaria to the Trematoda, though the second author was of opinion that further researches as to the vascular system of the Planarians were needed to render the relationship distinct. In his report on the memoirs of De Quatrefages, M. Milne-Edwards observed that the Nemerteans approached the Annelids by the general disposition of their vascular system, the leeches by the structure of their buccal system and other parts of their organization, but that their reproductive and digestive organs were homologous with those of the helminths. He compared their nervous system to that of the "Lingules." The statement with regard to the digestive system, however, is founded on erroneous observations, since both reviewer and reviewed mistook the proboscis for the alimentary canal, and thus instead of the latter forming a blind tube, it is open at both ends, and very different from that of any helminth. Œrsted, again, placed them after the Leeches, while M. Blanchard, misled by the observations of M. de Quatrefages, exaggerated the gulf between the Nemerteans and the Planarians so much that he thought their affinities lay rather with the helminths than with the latter. Dr. Thomas Williams considered his closed alimentary chamber (digestive canal) the homologue of the spongy mass in Tænia, but this is open to doubt. He also drew a resemblance between the Nemertean reproductive organs and the "ovarian or female series" in the leeches. So struck was this author by the differences between the Nemerteans and the Planarians (which he affirmed were only allied by the ciliated integument), that he proposed to separate the former from the "true Turbellaria" under the name of the Cestoid Annelids. I think, however, that we are scarcely warranted on structural grounds in making so radical a change.

Amongst recent writers, Dr. Cobbold, it appears to me on somewhat insufficient data, has grouped the Turbellaria under the class *Helmintha*, which he conveniently widens to allow them, as he thinks, to be near their allies the Trematoda. But it is to be observed that, while the Planarians perhaps do approach the Trematoda, the Nemerteans diverge so much that the relationship is very difficult to discover. The outline of the ovate and flattened Planarian somewhat resembles that of the Distomes and their allies; but there is nearly as much similitude between the former and an *Elysia* or *Limapontia*, or again between a *Sagitta* and a Fish. The cutaneous texture of a Trematode (for instance, *Fasciola hepatica*), according to Dr. Cobbold, is covered with minute chitinous processes or spines, and is composed of an outer transparent epidermis, and an inner fibrous cutis. In the Planarian, on the other hand, we have the ciliated epidermis and the characteristic soft, cellular cutis, so conspicuous for its secretion and its tendency to diffluence under examination. "In the *Fasciola* the next layer is composed of numerous bands of muscular fibres, in which four separate groups may be recognized more or less distinctly. They have been described as so many layers, but they are not readily separated from one another." Such is the description this author gives of the muscular system. In the Planarian the muscular layers form distinct coats, which cannot be confounded, and moreover they seem to be formed after a different type. I would, however, remark that in a transverse section of *Campula oblonga*, Cobbold, a Distome from the bile-ducts of the Porpoise, there is below the chitinous cutis a delicate layer of circular fibres—slightly indented by the bulbs of the chitinous spines, and having a thin coat of longitudinal fibres underneath. Such therefore agrees with what Prof. Owen found in *Distoma clavatum*. Dr. Cobbold also speaks of soft parenchymatous tissue filling up the general cavity of the Fluke, and though not averse to such a disposition as a proof of further divergence of type, yet in the Distome just mentioned (*Campula oblonga*) transverse and longitudinal sections show a complex arrangement of fibres and cells—only inferior to the more differentiated muscular bands, fibrous tissue and cells, the presence of which in the Planarian is so intimately connected with the physiology of the parts. In the case of the digestive system there is apparently some analogy in form, since both Planarians and Flukes have branched, cæcal, alimentary organs, but then *Vortex*, and the whole of the Nemerteans to which the Planaria Dendrocœla are linked, deviate in a still greater degree from the parasites. The oral sucker of the fluke has little homology with the protrusible proboscis of the Planarian, and still less with the mouth of *Vortex* or the Nemertean. Moreover, the microscopic structure of the digestive ramifications of the Planarian agrees very closely with the same organ in the Nemertean, while it differs entirely from that of the fluke, with its "fibrous wall" and "columnar cellules," or, as I should call them, papillæ. Such differences probably depend much on the divergent character of the food. Dr. Ehlers, in his arrangement of Worms, separates the Nemertinea (Class V) from the Turbellaria, Ehrenberg, s. str. (Class IV), and interpolates the round worms and Gephyrea between them and the Annelida. It is doubtful if the Gephyrea are a higher type than the Nemertinea, and they certainly do not approach the true Annelida more closely. Prof. Huxley, again, groups the Nemerteans amongst the SCOLECIDA, characterising the "water-vascular system" of this heterogeneous class as having ciliated tubes throughout. This, of course, cannot apply to the Nemerteans, and not even to the Planarians.

The branched water-vascular system (which Prof. Owen regards as excretory) of the Fluke has no counterpart in the Planarian, and cannot be supposed to be closely allied to the vessels of the Nemerteans.

A decided difference is apparent in regard to the nervous system, which is much more conspicuous in the Planarian than the Fluke; indeed, observers who are familiar enough with other parts of the structure of some species of the latter have not seen such at all. It is described by Prof. Owen in *Distoma clavatum* as in the form of a pair of cephalic ganglia connected together by a thin commissural filament above the pharynx, and giving off two main lateral nerves. Two much larger ganglia occur in the Planarians, connected by a broad commissure, and the branches to the surrounding parts are more distinctly arranged. Prof. Owen states that pigment-specks, called "eye-specks," are present in the Polystoma of the urinary bladder of the toad and frog, as in the locomotive ciliated larvæ of most Trematoda; but as a whole the special organs of sense are much more highly developed in the Planarian.

In regard to reproduction there is some resemblance between the groups, both Flukes and Planarians having male and female organs developed in the same animal. Both are oviparous, and the ova produce ciliated embryos; but the young of the fluke soon lose the cilia, and represent only the first stage of a series of metamorphoses which occur before reaching maturity. The embryo of the Planarian, while, perhaps, undergoing metamorphoses in some cases, comes out of the egg in others nearly in the same form as the adult, and never loses its cilia at any period. Besides, too much reliance cannot be placed on this common metamorphosis, for we may as readily arrange the Echinoderms with the Nemerteans on account of the *Pilidium*-development, as class the Planarians with the Trematoda on this account.

The habits and motions of the two groups, it is well known, are widely different.

Having thus indicated some of the chief points of divergence and affinity between the Planarians and the *Trematoda*, we may now examine the relationship between the former and the animals with which we have more particularly to deal, viz. the Nemerteans.

In regard to the general structure of the cutaneous textures there is much resemblance. Both have a ciliated cuticle, a soft, easily disintegrated cutis, chiefly composed of cells and areolæ, and capable of secreting abundant mucus. In the skin of no Nemertean, however, have I seen any urticating or "stabförmigen" bodies.

The muscular coverings are similarly grouped into definite layers of longitudinal and circular fibres. On the ventral surface of the Planarian, however, we sometimes have an inner layer not represented on the dorsum, a fact that has been overlooked by Professor Keferstein in his recent valuable remarks on the Planarians.[1]

The digestive systems, though apparently divergent, are really allied in an intimate manner. The mouth in the Planarians follows the habit of the organ in the Anopla in opening behind the ganglia, but more posterior in position. The large proboscis in the Planarians is probably homologous with the œsophageal division of the digestive tract in the Nemerteans; and in the typical *Lineidæ* amongst the latter the œsophageal region is frequently everted during feeding in the form

[1] 'Beiträge zur Anat. u. Entwicklung. einiger Seeplanarien,' &c., 1868.

of a rugose prehensile organ. The ramose nature of the digestive cæca, which are all connected with a central cavity, is but a modification of the pinnate organ in the Nemerteans, the pinnæ in certain of the latter being even slightly branched. Moreover, the microscopic structure of the walls of this system (with perhaps the exception of the inner coating of cilia) is similar, and in both cases appears to combine the biliary with the intestinal system proper. In the Planarians, however, there is no anus, while such is present in all the Nemerteans. The system as a whole shows a higher degree of advancement in the latter, the connecting links apparently occurring in the Anopla, whose mouth opens behind the ganglia as in the Planarians.

The nervous systems of the groups are also related. The cephalic ganglia are two in each, but those of the Nemerteans are connected by two commissures, a dorsal and ventral, whereas in the Planarians there is only a single large commissural band, which is homologous with the ventral of the Nemerteans. The separation of the ganglia in the latter is more distinct than in the former, though this does not necessarily imply a higher type; indeed concentration of nervous matter is generally considered to be so. The senses in the groups are somewhat similar; over the entire surface touch is as exquisite in the one as in the other; the organs of vision consist of two well-marked series in each, viz. those with and those without apparent lenses or capsules, so that the pre-eminence in this respect is hard to adjudge, though I am inclined to give it to the Nemerteans. There is some doubt about auditory corpuscles or otolites in either group, though Gräfe and Keferstein mention their occurrence in certain Nemerteans. I have never seen such. The function of the special cephalic pits and neighbouring glands in the same animals is involved in obscurity. They may represent the segmental organs of the higher Annelids, or, perhaps, with greater probability, may be taken as the homologues of the water-vascular system.

In the circulatory system the Nemerteans much excel the Planarians. In none of the latter is there any circulation in distinct vessels, while in the former group all possess such, the vessels being filled with a more or less corpuscular fluid. It is true that a water-vascular system is described by O. Schmidt in certain freshwater Turbellaria, and that Max Schultze mentions a system of canals in *Thysanozoon* and *Polycelis*, but I agree with Professor Keferstein, after a careful examination of spirit-preparations, in considering further investigation necessary, and that in the present state of our knowledge we cannot admit this in the ordinary Planarians.

Considerable divergence occurs between them in regard to the organs of reproduction, the Planarians being hermaphrodite, while almost all the Nemerteans have the sexes separate. In regard to the complexity of the sexual system the former excel the latter, whose organs consist simply of a series of sacs placed along the sides of the body—for the development of ova or spermatozoa. Moreover, where hermaphroditism appears, as in *Borlasia hermaphroditica* and *B. Kefersteinii,* respectively described by Professor Keferstein and A. F. Marion, one part of the body has its sacs filled with spermatozoa and another with ova, or the male and female elements occur in the sacs without definite order as regards position, so that the type of structure remains unaltered, and essentially different from the arrangement in the Planarians.

The development of the young in the two groups has certain features in common, others at variance. Thus the ova of the Planarians in some instances produce ciliated embryos that have at birth more or less the form of the parent,—which form they retain throughout. The group Enopla of the Nemerteans agrees with the former; while in the division Anopla the young either emerge from a ciliated covering inside the egg-capsule, or they are produced from the *Pylidium*-form in the free state. Moreover, some of both great Nemertean groups are viviparous, the ova being long enough retained in the ovisacs to develop their contents, after impregnation through the lateral (sexual) pores.

In the homologies of no organ, however, does the separation between the Planarians and Nemerteans become more apparent than in those of the proboscis, which, with all its adjuncts, appears to be a structure purely Nemertean.[1] Its definite aperture in front, its relation to the ganglionic commissures (between which it passes), its remarkable microscopic structure, and distinct muscular sac or sheath containing the highly organized corpuscular fluid, all point it out as an organ *sui generis*, and apparently without prototype or homologue in the Planarians or their allies. As already mentioned, I am inclined to consider the proboscis of the Planarian as the analogue and homologue of the œsophageal division of the digestive tract in *Lineus* and *Amphiporus*, and the "Schlund" of *Vortex*. The diminished size and atrophied condition of the proboscis in *Prorhynchus* seem to lead on the Nemertean type to certain of the Rhabdocœla.

Both groups are characterized by great recuperative powers after injury, new parts and organs replacing those that have been cut off; while mere fragments not infrequently grow into perfect animals.

Both consist for the most part of predatory and carnivorous creatures, that, notwithstanding their general deprivation of organs of offence and defence, manage to prey on animals much higher in the scale of organization than themselves, such as the Annelida. Their habits are also in many respects similar.

Bipalium.

I thought that considerable light might be thrown upon the affinities of the Planarians and Nemerteans by an examination of *Bipalium*, whose elongated body and central mouth indicated the probability of its intermediate position.

In *Bipalium*[2] there is externally (in the preserved condition) a rather dense cellular cutis, similar in structure to the same coat in the Planarians and Nemerteans, though less defined from the subjacent investment, which consists in this case of a thin belt of circular muscular fibres. There next occurs a longitudinal muscular layer, split into isolated fasciculi, between which certain pigmentary and cutaneous elements and connecting fibres lie. Thus the coat in transverse section presents a barred appearance, especially in the dorsal region, where the pigment is most marked, the dark band being interrupted by the pale longitudinal fasciculi. In superficial longitudinal sections, also, the same aspect is caused as in *Lineus* by the intrusion of the pigmentary and cutaneous elements amongst the muscular. The intermediate region below the coat just mentioned has numerous cells and granules amongst the fibres which connect it with the next layer and the general stroma of the body-cavity. There are also many cells, often of a flask-shape, with the narrow end external, filled with long and somewhat spindle-shaped

[1] It is probable some further light will be thrown on the homologies of this organ in the anatomy of the Annelida.

[2] I am indebted to Prof. E. P. Wright, of Dublin, for the opportunity of examining this form, which was kindly placed in my hands along with many foreign Annelida collected by himself. His genus *Dunlopea* is synonymous with *Bipalium*.

filamentous processes, which are termed by Schmarda "stäbchenförmigen Körpern." The most prominent features of the complex muscular arrangement filling up the body-cavity after the full bulk is attained are the following:—Within the intermediate layer all round the body are many longitudinal muscular bundles clasped in isolated fasciculi by divergent or curved fibres. Thus, with the exception of the central digestive cavity, the whole mass of the body is filled up by these interlacing, longitudinal, and other fibres.

For some distance at the tip of the snout the stroma quite fills the region, but shortly a differentiation ensues, caused by the prominence of three transverse bands of muscular fibres, which pass across the snout at a distance from each other, so as to leave spaces occupied by fibres which have more or less a vertical direction. At first the arrangement is merely indicated, but it steadily gains so distinct a character that at last a series of spaces is left in transverse section in the dorsal division. In their fully developed condition these spaces have a thick layer of cellulo-granular matter, forming an inner lining or investment, which is so consistent that, in some fine sections which have been torn, it remains as a ring, with a well-marked outer margin. There is much opaque granular matter, also, between the vertical fibres. The channels—now larger and better defined—become continuous with the anterior part of the digestive chamber. They are about twenty in number in the snout.

The long pale area (in transverse section), which forms with the preceding in the snout, though streaked by the vertical granular bands, presents a much more translucent appearance. Towards the tip it is a simple transverse pale belt, wider in the middle, tapering at the ends, and passing entirely across the snout, the usually opaque cutaneous margin being more translucent opposite the ends in such a view. At first it is more conspicuous than the dorsal belt, but after the three vertical bands previously described appear, the two areas are nearly equal in breadth. No aperture, however, occurs in that now under consideration. It becomes gradually more transparent and wider in the middle; and by-and-by there is a tendency to enlargement on each side of the median line, while the vertical fibres forming the latter increase in prominence. A pale ventral region also makes its appearance, at first faintly marked, then more distinctly; the cutaneous textures, moreover, being included in the pallor. This causes the translucent region on each side of the median line to assume a long club-shape, and then—as an increase of the opaque fibro-granular matter occurs in the centre—a wedge-shape. The central septum afterwards (proceeding backwards) gets wider, a ventral prominence becomes distinct, and the wedge of pale tissue shortens and assumes a somewhat ovoid form. Some pale fibres stretch across the septum between each ovoid space. With a few changes as to size and separation this arrangement continues to the posterior end of the worm, where it gradually ceases. So far as I can make out, the pale bands (just described in transverse section) are not composed of nervous tissue, for which they appear to have been mistaken by Schmarda.

The proboscis of the animal is Planarian in structure, having a glandular investment, with subjacent circular and longitudinal muscular fibres—the former being most conspicuous immediately below the mucous surface, and an intermediate and apparently erectile tissue. The digestive tract throughout is also Planarian. It is branched in front and laterally, and towards the posterior end becomes divided by a perpendicular septum into a right and a left division.

The structure of the generative system as described by M. Claparède[1] shows a wide divergence from the Nemerteans.

[1] 'Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève,' tome xvi, 2eme partie, pp. 293—312, 1862.

This animal, therefore, leans to the Planarian rather than the Nemertean type; and on the whole it would appear that, while the affinities of these groups are sometimes in accordance, there can be little doubt as to the higher position of the latter in almost every respect.

Balanoglossus.

Two species of *Balanoglossus* dredged in the last cruise of the "Porcupine" (1870), in the one instance by Mr. Jeffreys outside the Strait of Gibraltar, to the south of Tangier, in 128 fathoms,[1] and in the other by Dr. Carpenter off the Algerine coast, at a point intermediate between Capes Falcon and Tenes, in 51 fathoms,[2] gave me an opportunity of investigating an apparently intermediate type of much interest. Unfortunately, none of the specimens were in good condition, either from rapid decay before being placed in spirit, or some other cause. None of the fragments exceeded $1\frac{3}{4}$ inch in length, and the diameter at the collar or widest portion was about $\frac{3}{8}$ths of an inch.

The general appearance of those dredged by Dr. Carpenter resembles the penis, the short conical anterior end or "proboscis," with the overlapping collar behind, closely imitating the *glans penis*, with its prepuce retracted. On the dorsum the "proboscis" is marked by a furrow at its base, and, continuous with this on the body, two well-marked ridges course along the median line. On the ventral aspect is a deep median furrow, a groove also being present on the head in the same line. The body is rounded anteriorly, flattened posteriorly.

The "proboscis" exhibits various appearances, from the bluntly conical form in contraction to a more elongated and pointed contour in partial extension; and it is evidently a very mobile muscular organ. On reaching the collar, its base becomes contracted all round, so as to be connected with the trunk only by a narrow pedicle, which is attached just over the anterior opening or mouth, the whole having the appearance of an operculum or plug. The anterior end or "proboscis" has lost its dermal layers in all the preparations, showing externally a tough, translucent and slightly granular membrane, probably the representative of the basement-membrane of the cuticular tissues. A considerable belt of circular muscular fibres forms the next investment. In transverse section a large number of vertical lamellæ are observed to be arranged within the latter coat, in a divergent manner with regard to the central space. These can readily be split from each other in a longitudinal direction, yet so intimately do the fibres mix that in longitudinal sections their main direction is longitudinal, while they follow a transverse direction in transverse section. From the shape of the region the lamellæ become narrowed in front and widened posteriorly. The nature of the specimens did not warrant a decision as to the presence or absence of a terminal pore, but, from an examination of specimens in the living condition, other authors, such as Delle Chiaje,[3] Keferstein,[4] Kowalewsky,[5] and Willemoes-Suhm,[6] have observed one. The posterior end of the "proboscis" in contraction fits into a kind of cup

[1] No. 36, surf. temp., 75°; bottom, 55° Fahr.

[2] No. 50, „ 75°; „ 54° 7′.

[3] 'Memorie sulla storia e not. degli,' &c., vol. iv, p. 117.

[4] 'Untersuchungen ueber nied. Seethiere,' p. 91.

[5] 'Mém. de l'Académie imp. des sc. de St. Pétersbourg,' vii[e] sér., tom. x, No. 3, 1867.

[6] 'Zeitsch. f. w. Zool.,' Bd. xxi, 3, p. 383.

formed by the fleshy collar of the body, which projects after the manner of that in *Terebella*, but without the break or fissure.

In his excellent account of the anatomy of *Balanoglossus clavigerus* and *B. minutus*, Kowalewsky describes the chief muscular fibres of the "proboscis" as longitudinal, and the circular as insignificant. This does not quite agree with the state of the parts in the foregoing examples.

Structure of the Body-wall.

Few traces of the cutaneous elements remain in any of the specimens, but the structure of fragments in the furrows demonstrates that it is allied in the closest manner to that of the Nemerteans. The cutis consists of a multitude of cells and globules in a gelatinous intercellular substance, the skin on section being streaked and loaded with circular and elongated granular masses, as in the former group. Indeed, the ease with which almost the whole cutaneous elements had separated from the subjacent tissues corroborated the relationship. A tough and continuous basement-membrane, having a finely streaked appearance, intervenes between the former and the next coat, which is a thick layer of longitudinal fibres, most developed, perhaps, on the ventral surface. The interfascicular substance is slightly marked, but there are many intersecting fibres which radiate inwards from the outer margin of this investment, through the next layer, to the wall of the digestive chamber. In longitudinal sections the longitudinal coat has, therefore, a transversely streaked aspect. It also presents three well-marked dorsal gaps anteriorly, viz. a median and two lateral, while ventrally a single hiatus exists in the centre. The circular muscular coat, which comes next in order, is moderately developed. The space between the latter and the wall of the digestive canal is partly occupied by the divergent fibres previously mentioned, the glandular or "liver"-tissue, and a few cells and globules.

The examination of living specimens enabled Kowalewsky to see the cilia with which the whole integuments are covered, and he further describes a fine "cuticula;" but, so far as an examination of preserved specimens warrants me in affirming, this structure is not more differentiated than in the Nemerteans, and therefore not demonstrable histologically as a special layer. In his anatomy of the body-wall he places the circular muscular coat to the exterior of the longitudinal—beneath our basement-membrane, and thus his specimens deviate in type from the foregoing.[1]

Within the circle formed by the collar a conical process having a filiform terminal appendage projects from the truncated anterior extremity of the body, and fits into the hollow at the base of the "proboscis." This structure is supported upon a somewhat enlarged firm base, round which the tough basement-membrane of the "proboscis" is fixed. Below the line of attachment of the latter the process is again narrowed, and presents just over the opening of the

[1] There would seem to be considerable variety in the structure of the body-wall of these forms. Another species dredged in 125 fathoms off Cape Rosier, in the Gulf of St. Lawrence, by Mr. J. F. Whiteaves, shows (in the spirit-preparation) underneath the glandular lining of the digestive chamber all round a dense and almost cartilaginous layer marked on its inner surface by regular transverse striæ, but there is no specialization of chitinous tissue as in the Mediterranean examples.

mouth a smooth eminence of cartilaginous density, tinted of a reddish-brown hue. This terminates posteriorly in two brown chitinous rods, which diverge along the margin of a firm valvular process (forming on each side part of the lips of the oral aperture) and support the axis to which the "proboscis" is attached. A pointed and somewhat dense papilla lies at the fork of the chitinous processes. On the dorsal aspect of the valves and in the central line of the animal a series of transverse bars or ridges commences on each side. They are arranged in a double row, separated by a well-defined median furrow, which corresponds with the groove between the dorsal ridges externally. When first observed these firm bars had somewhat the appearance of a vertebral column—split as in a dried fish, and this special chitinous skeleton might therefore furnish the modern theorist with as good grounds as usual for the demonstration of the true stepping-stone to the vertebrate series. They are upwards of seventy in number, commencing by a well-marked chitinous bar just behind the fork of the axial processes, and, from the gradual diminution of the rows, terminating in a somewhat pointed extremity. Generally the whole structure may be separated into two divisions, viz. septal and branchial proper. Each septum is furnished with a brownish chitinous rod, which is conspicuous throughout its entire length in front, but is chiefly observed towards the median line posteriorly. These septa mark off the branchial spaces, since by splitting and uniting with others at the outer extremity, a branchial furrow is completed. From a point a little exterior to the median line each septal rod passes outwards to bifurcate as already mentioned, its course being easily seen anteriorly on account of the brownish hue of the process. This colour, however, is really confined to the central part of the flattened organ, which has throughout a thin translucent edge above and beneath, and is densest near the fork of the branchial lamella. From each side near its base is given off a translucent lamina, which, with another from the adjoining septum, forms the support of the branchial sabre. The junction of these laminæ with the septal process is interesting, for in transverse section the base presents the form of an anchor. The septal rod, elevated on a fold of the basement- and mucous membrane, constitutes the strong central support (shank) of the T-shaped structure, while the branchial laminæ, passing from the transverse bar as long recurved processes, correspond to the flukes. At the junction of the septal rod with the transverse portion is a slight swelling of the former, having the brown chitinous part in the centre, the rest of the process, as well as the branchial laminæ, being quite translucent. As the sections proceed outwards, however, a slightly brownish hue from the presence of dense chitinous matter is seen at the base of the branchial laminæ where they join the septal rod. The latter is marked almost from the commencement by a vertical median line, showing its double composition. The branchial laminæ at this part touch at the lower edges, but gape at the upper, so as to make a triangular channel, which is completed by the thick membrane of the region. Further outwards the branchial arches stand freely in their grooves, their supporting chitinous laminæ being enlarged at the upper end and bent inwards in transverse section, and the tunnel completed by the membrane formerly described. The supporting chitinous rods gradually taper from the median line to the outer edge, as also do those of the septal regions; thus the diminution in the former case has to be compensated by an increase of the soft parts of the tunnel. After the branchial lamella forms an independent sabre in the groove, the septal process is found (in transverse section) elevated on a still higher fold of the mucous membrane as a club-shaped structure, the central brown chitinous part—somewhat triangular in shape—appearing in the rounded summit. The next change is the increase of the brown hue in the chitinous supports of the branchial lamellæ. The double nature of the septal process also becomes more evident, even from the fold of membrane upwards. The summit, however, is still uniformly coated by the investing membrane of the branchial region; by-and-by the papilla on which it is placed shortens, and the pale chitinous tips of the rods split to form the arch at the boundary. The laminæ of the branchial processes diminish into slender pale chitinous rods, which lie towards the inner (lateral) margin of the canal, and each soon terminates in a closed extremity. Over the whole of the processes just described a thick mucous layer, probably ciliated during life, is spread. In ultimate structure it is glandular in appearance, being finely streaked in vertical section and minutely granular. A peculiar fibrillated condition is observed in that forming the wall of the branchial lamella, and also at the base of the chitinous supports of the septa. This mucous layer rests upon a basement-membrane, from which numerous divergent fibres pass to the exterior muscular coat of the body-wall, here and there enclosing spaces for the fatty "liver"-structure found in this region.

The foregoing account, of course, is only meant to convey a description of the framework of the branchial apparatus, which in other respects has received careful treatment from the excellent Russian naturalist Kowalewsky. The arrangement of the system in this form shows a close approach to that of *Balanoglossus clavigerus.*

Accessory Glands to the Digestive System.

Anteriorly a considerable space occurs between the dorsal surface of the branchial apparatus and the body-wall, which is occupied for the most part by transversely arranged sacs of the yellowish fatty "liver"-tissue. These bodies are surrounded by a distinct membrane, enclosing a vast number of compound fatty globules and granules, similar in minute structure to the same tissue in the Nemerteans. In transverse section the contents seem to fall out of the centre, but a thick layer of globules still adheres to the wall of the sac. These saccate glands occur under the branchial lamellæ, and generally in the space between the inner muscular layer and the wall of the digestive tract anteriorly. As soon as the branchiæ cease, however, they become much more prominent. The digestive and respiratory functions are thus performed in one chamber anteriorly, and the structure and arrangement throw considerable light on the condition of the same part in the Nemerteans, where a characteristic distinction exists between the two regions of the digestive system. Kowalewsky shows a folding of the branchial region in his species, so that a special chamber is separated from the general alimentary cavity. The digestive would therefore not intrude on the respiratory function.

Digestive Cavity Proper.

This chamber commences at the oral aperture, and continues in the form of a wide tube to the posterior end of the animal, which, however, is incomplete in all our examples. It is supported and held in position by the radiating fibres that pass inwards from the external muscular coat of the body-wall. Anteriorly the glandular mucous membrane, which forms its inner coat, presents a frilled appearance, from the rugæ, which, as in the Nemerteans, often assume an arborescent appearance, owing to the extrusion (under pressure and preparation) of their cellular and granular elements. The wall of the canal is somewhat thinner in front, while the glandular lining is largely developed. Behind the branchial region, however, the following structure is clearly seen:—Externally the radiating fibres from the outer coat of the body-wall pass into a well-marked layer of circular muscular fibres, upon which the continuous basement-membrane and its glandular lining rest. The latter is thinner than in front. The structure on the whole closely approaches the Nemertean digestive tract.

Kowalewsky mentions that the surface of the digestive chamber is richly ciliated. His specimens occurred on sandy ground, as might be expected from the nature of their food.

Circulatory system.

Two vessels only could be satisfactorily made out by an examination of the specimens. A large longitudinal dorsal vessel lies over the fibrous band connecting the branchial septal rods across the median furrow. At this point it has externally only the circular muscular coat, the basement-membrane and cutaneous tissues, since there is a hiatus in the longitudinal muscular layer. The vessel is continued to the posterior end of the specimen over the wall of the digestive tract. Exactly in the median line on the ventral surface a similar vessel occurs, with the same relations to the cutaneous and alimentary textures. Both trunks have distinct walls. Besides the elaborate arrangement of vessels in connection with the branchial lamellæ, Kowalewsky shows a lateral vessel on each side, and various minute twigs from the larger trunks.

A single imperfect example of the other form of *Balanoglossus* was dredged by Mr. Jeffreys as above mentioned. In general features and size it resembles the foregoing, but certain anatomical differences merit special notice.

The "Proboscis" consists of a bluntly conical mass, which has lost its cutaneous elements. Externally, instead of the basement-membrane and circular fibres of the former type, there is a coat of longitudinal fibres, or, rather, of fibres whose direction is chiefly longitudinal, for they are felted firmly together. Within is a belt of circular fibres, from which the vertical lamellæ of the central region spring. The lamellæ consist of fleshy columns, which are fixed to the outer wall all round, but have a free margin internally. In transverse section, thus, the region somewhat resembles the kind of fruit called *hesperidium*, such as that of the orange, only the carpels are enormously increased. The columns are composed of densely felted fibres—longitudinal, oblique, and radiating, besides circular fibres towards the inner free margin. The whole must therefore form a powerful squeezing or propelling organ, after the manner of the heart of the higher animals. This region is attached to the body by an elongated, chitinous, process which has a broad basis at the mouth, and sends four divergent chitinous spurs into the tissues for support, the posterior pair coursing along the borders of the dorsal valves or lips, as in the previous form. The broad, fleshy collar has two powerful conical bands of fibres (continuous with the dorsal belts) attached to the chitinous process on the dorsum, while ventrally a special bundle of fibres passes from the collar to the anterior margin of the trunk.

The dermal layers of the body agree in both species, as also does the external (longitudinal) muscular coat; but though certain circular muscular fibres lie under the latter, they are so indistinct as scarcely to merit the name of a special layer.

A considerable difference is apparent on opening the body-cavity, as at first sight the branchial arrangement characteristic of the former examples seems to be absent. On careful inspection, however, many minute, transparent, chitinous processes are found in the somewhat thickened membrane behind the dorsal valves. These processes have the form of a pointed molar tooth with very long fangs, and a fissure passing up the centre of the tooth to the crown. Some of the fangs or processes are bifid at the tip, each division diverging with a curve from the main stem. In all probability they form a short double row, after the type of the former species; but the specimen is not in a condition to bear searching investigation.

The digestive canal and accessory glands have a similar character to those in the foregoing species; the former being distended with muddy sand containing many Foraminifera and other microscopic organisms, the latter chiefly grouped along the dorsal area.

This species would not seem to approach any yet described.

In reviewing the several features presented by these curious forms, and contrasting them with what is known of Nemertean anatomy and physiology, the following reflections occur:—

In both the cutaneous tissues have the closest similitude as regards ciliation and minute structure. In *Balanoglossus*, however, the basement-membrane underneath the latter is more differentiated, and assumes a slightly fibrous appearance.

In the arrangement and histology of the muscles of the body-wall they much resemble each other.

The digestive system is similar. Both have a ciliated chamber divided into two great regions, represented by the first or branchial, and the succeeding division in *Balanoglossus*, and by the œsophageal and alimentary cavity proper in the Nemertean. The peculiar *rete mirabile* over the œsophageal region of the Nemertean, and the elaborate branchial circulation of *Balanoglossus* are apparently homologous. The minute structure of the proper wall of the chamber is closely allied. Moreover, while the "liver"-tissue is separated into elongated sacs in *Balanoglossus*, and simply diffused over the alimentary region in the Nemertean, its histological features are nearly identical. The mouth and anus are also similarly arranged.

With regard to the "proboscis" of *Balanoglossus* and that of the Nemertean I fear there is no homology; indeed, I would be inclined to regard the anterior region in *Balanoglossus* rather as the homologue of the Nemertean snout. The pore at the tip in the former would therefore correspond with the aperture for the proboscis in the latter, the mouth in both being placed a considerable distance backwards.

A great divergence happens in regard to the nervous system. It is not yet sufficiently understood to enable us to form a correct idea of its relations in *Balanoglossus*, while it is conspicuous in the Nemertean.

There is considerable similitude in the circulatory system. Both have a main dorsal and two lateral trunks, the blood in each group flowing from behind forward in the dorsal. The much greater differentiation of the branchial region in *Balanoglossus* necessitates a corresponding complexity of the vessels, yet there is a connecting link in the elaborate plexus in the œsophageal region of the Nemertean.

In regard to generation and development there is also a parallelism. The reproductive elements are developed in sacs in both, and the sexes are often distinct. Certain of the young in each case undergo a kind of metamorphosis, as shown on the one hand by the description already given, and on the other by the interesting observations recently made by E. Metschnikoff on *Tornaria*,[1] apparently the early condition of *Balanoglossus*. The occurrence of eye-specks in the anterior region ("proboscis") in the latter would seem to indicate that the above view of its homologies is correct.

Having thus examined the relations and homologies of the Nemerteans with their inferiors and apparent equals in the scale, we may next inquire into their affinities with the higher annelids. Here, however, there is room for very diverse opinions, since, so far as known, there are no intermediate forms through which they may be linked on to any higher group.

Their relationship would rather appear to be with the Leeches than with the *Gephyrea* or *Scoleidæ* of Prof. Allman's classification, although a considerable gulf intervenes. Thus, in regard to the cutaneous system the cilia are not present in the leeches, though the exudation of the cutis proper is abundant enough. The muscles of the body-wall are less definitely arranged in the latter (*e.g. Nephelis*), the internal longitudinal bundles for instance being placed in the body-cavity, and separated by regularly arranged vertical fasciculi at the lateral regions. The external coat is composed of circular fibres, within which lie a decussating series. The digestive system opens by a mouth in front of the ganglia, after passing through a nervous collar, and the muscular œsophageal region is distinguished from the more glandular stomachal portion, as in the Nemerteans. There are no cilia in the alimentary chamber, but it is occasionally furnished with cæcal processes. The alimentary canal adheres as much to the body-wall in the Leeches as in the Nemerteans, which in this respect differ from the higher Annelids. The dorsal and the two great lateral vessels of the leech are probably homologous with the three vessels of the Enopla, but the ventral is additional.

In regard to the nervous system, the superior lobes of the Nemertean brain seem to correspond with the supra-œsophageal ganglia of the leech, and the inferior (from which the great lateral trunks arise) with the sub-œsophageal. If in the Enopla the two ganglia were separated, and the lateral nerve-trunks thrown together in the median line of the body, the alimentary canal would become dorsal in position, and would perforce pass through the nervous system to open ventrally, while the lateral vessels would remain in their usual situation. Thus a partial resemblance to the state in the leech would ensue. A much greater amount of branching of course would occur after the concentration of the nervous system.

The two cephalic sacs and coiled ducts in the Enopla may be the homologues of the segmental organs in the leech.

[1] 'Zeitsch. f. w. Zool.,' Bd. xx, p. 131, taf. 13, 1870.

There is a considerable difference in regard to the reproductive organs, for the Leeches are hermaphrodite, whereas the Nemerteans are chiefly unisexual. The capsule of mucus for the ova in *Lineus* is homologous with the cocoon of the leech; the latter being apparently due to the same abundant secretion poured forth by the general cutaneous surface, and is not necessarily connected in any way with the numerous segmental organs. Some of the higher Annelids, again, agree with the Nemerteans in discharging the generative products through lateral pores, *e.g. Harmothoë* and *Phyllodoce.* As in the Enopla, no metamorphosis occurs in the embryo of the leech. All the latter are oviparous, whereas some of the former are ovo-viviparous.

There is no feature to connect them with the *Brachiopoda,* which Mr. Morse[1] thinks should be classed with the true Annelida; indeed, we are not prepared at present to admit the relationship until we are more acquainted with the grounds on which the American author bases his conclusions.

I would be inclined to place the Turbellaria next the true Annelida, without the usual interpolation of the Rotatoria.

General Distribution of the Nemerteans.

The Nemerteans have a very wide geographical range, extending from the arctic seas to those of the equator, and it is probable they occur on every suitable sea-beach, as well as in the surrounding depths. The forms adapted for swimming generally frequent the latter, and perhaps only approach the shallow water at the extreme limit of their range, and in a somewhat modified form, especially as regards size. Moreover, examples of the two great types (Enopla and Anopla) are common both to the arctic seas and the antipodes. The range of the freshwater species is involved in obscurity; they have been found in various parts of the world, but not yet in this country.

With regard to the distribution of the British species, some forms are cosmopolitan, such as *Amphiporus lactifloreus, Tetrastemma melanocephala, candida,* and *dorsalis, Nemertes Neesii, Lineus marinus, L. gesserensis, Cerebratulus angulatus,* and *Carinella annulata,* extending from the Zetlandic seas along both eastern and western shores to the Channel Islands, and, in addition, radiating widely all round. Thus I have received *A. lactifloreus* from Greenland, and apparently the same form is described by M. de Quatrefages from the Mediterranean. *Tetrastemma melanocephala, T. candida,* and *T. dorsalis* range from the latter to the extreme north of Europe. *Lineus gesserensis,* again, appears to be even more widely distributed, for besides being prevalent in the European seas, it (or a form almost identical in every respect) extends to the shores of the United States. *Cerebratulus angulatus* attains greater dimensions in the seas of Greenland and the Boreal province generally than it does in the Channel Islands. In other forms, however, *e.g. Lineus marinus,* I have observed no apparent difference in bulk between those from Shetland and those from Guernsey; though at the same time it must be stated that nowhere have the Nemerteans occurred of greater size and beauty than amongst the sheltered tangle-forests of the

[1] 'Ann. Nat. Hist.,' 4 ser., vol. vi, p. 267.

Zetlandic seas. *Carinella annulata* stretches from the north of Shetland to the Mediterranean, and a very similar species is found at the Cape of Good Hope.

Others, again, have a more southerly range, and have not yet been found in the northern portions of the British Islands; but on this point I would not speak dogmatically, for very much yet remains to be done in regard to the distribution of marine animals. *A. spectabilis*, *Borlasia Elizabethæ*, and *Micrura aurantiaca* may be instanced as specially southern forms.

Some of the Nemerteans live at a depth of many fathoms and at a considerable distance from land, as well as between tide-marks, for example, *Nemertes Neesii*, *Lineus marinus*, and *bilineatus*, *Micrura purpurea* and *Carinella annulata*. *Amphiporus pulcher* and *Cerebratulus angulatus* are rarely found elsewhere than in deep water, the limits being from 5 to 120 fathoms. Amongst the Nemerteans procured in the dredgings of the "Porcupine" in 1869 and 1870, no new form, so far as can be ascertained from the spirit-preparations, occurs. It is interesting, however, to notice that the Anopla much exceed the Enopla in number, the most abundant form being *Micrura fusca*, with its flattened and oar-like posterior extremity. *Tetrastemma candida*, again, was found at a depth of 420 fathoms, its usual site being the laminarian and litoral regions. Representatives of the Anopla come from the great depth of 795 fathoms off the coast of Portugal. The Planarians accompany them in these sites, and there is no reason why both should not be found at yet greater depths. *A. lactifloreus*, all the *Tetrastemmæ*, *Prosorhochmus*, *Nemertes carcinophila*, many of the *Linei* and *Micruræ*, and *Cephalothrix*, have their habitat between tide-marks, though sometimes at the extreme border of the litoral zone; indeed, as a rule, *Tetrastemma dorsalis* is a laminarian form.

M. de Quatrefages states that he has seen imprints in the rocks of Solenhofen and Strasbourg, which he thinks belong to Nemerteans, in the latter case especially to the "genus *Borlasia*;" and palæontologists have expressed similar opinions. The fossils in the lithographic stone of Solenhofen recently noticed by Prof. Ehlers[1] under the name *Legnodesmus* bear a close resemblance to such as might be caused by the Nemerteans; but a perusal of his excellent descriptions and drawings leaves an impression so indefinite that further and more extensive investigations are evidently necessary before a safe decision can be arrived at. The most interesting part of this paper is the account of his finding stylets in the *Legnodesmus* figured in taf. xxxvii, figs. 1 and 2. My acquaintance with the living animals leads me to entertain doubts as to their connection with the so-called fossil Nemerteans (*Nemertites*) of the Cambrian rocks; at least, those coils I have seen suggest the following ideas:—Since they are simply casts without organic remains, the worms which made them could only have done so in shallow water, so as to have raised the snout to the surface, and crawled off in the usual manner (by floating). Any other mode of departure would have blurred the tracks in a deposit so soft as to receive such impressions. Moreover, I have often observed similar contorted tracks in the soft muddy sand in tidal pools—tracks made by litoral univalves in their daily wanderings.

[1] 'Ueber fossile Würmer aus dem lithographischen Schiefer in Bayern.' Cassel, 1869.

DESCRIPTION

OF THE

GENERA AND SPECIES

OF THE

BRITISH NEMERTEANS.

GENERA AND SPECIES OF THE NEMERTEANS.

Sub-Order.—ENOPLA.

Proboscis furnished with stylets.

Family I.—AMPHIPORIDÆ.*

Sub-Family.—AMPHIPORINÆ.

Proboscis proportionally large.

Genus I.—AMPHIPORUS. Ehrenberg, 1831.

BEFORE the time of Ehrenberg the species of this group had chiefly been included under the genera *Fasciola* and *Planaria.* In his 'Symbolæ Physicæ,' published in 1831, this author established three genera, viz., *Polystemma*, *Ommatoplea*, and *Amphiporus*, for the reception of animals probably belonging to the present type; and, while there is room for doubt with regard to the exact nature of the first two genera, as illustrated respectively by the examples *Polystemma adriaticum* and *Ommatoplea tæniata*, it is quite clear to every observer that his *Amphiporus albicans* from the Red Sea is a characteristic representative of the *Enopla*, closely allied to *A. lactifloreus.* I have therefore deemed it right to use for the typical forms that generic name about which there can be no misunderstanding, and which name, moreover, is contemporaneous with the others. Usage, perhaps, inclined me to favour the adoption of the generic title *Ommatoplea*, but in the present state of our knowledge this nomenclature would not have been strictly appropriate, and by the discovery of the typical form from which Ehrenberg drew up his description it might be our misfortune to find that it is one of the Anopla, since there is nothing decisive in his account or figure. The name here adopted is not free from faults, for the Anopla as well as the Enopla have a pore at either end; but the term *Ommatoplea* stands in the same position, numerous eyes occurring in the one group as often as in the other. In his description of the genus, Ehrenberg, although noting and figuring the glandular papillæ of the proboscis, omitted to observe the stylets, and did not truly comprehend the situation and relations of the mouth, as he mistook the proboscidian aperture for the latter. The name *Polia* instituted by Delle Chiaje, and

[1] Ἀμφὶ and πόρος, an aperture.

adopted for this genus by M. de Quatrefages, was applied by its founder to examples of the Anopla.

In distinguishing the species of *Amphiporus* the chief characters are drawn from the arrangement of the eyes, the nature of the cephalic furrows, and the structure of the stylet-region of the proboscis.

Generic character.—Eyes more or less numerous and large, but never arranged in a square. Body rather short, and often flattened.

1. Amphiporus lactifloreus, Johnston. Plate I, figs. 1 and 2.

Specific character.—Eyes grouped in two series on each side. Body whitish, roseate or grayish.

Synonyms.

1776. *Lumbricus oxyurus,* Pallas. Miscell. Zool., p. 146, tab. 11, f. 7 and 8.
1828. *Planaria lactiflorea,* Johnston. Zool. Journal, vol. iii, p. 489.
1837. *Nemertes lactiflorea,* Johnston. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 2 and 3.
1841. „ „ W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.
1843. *Borlasia? alba,* W. Thompson. Rep. Brit. Assoc., 1843, p. 271.
1844. *Polystemma roseum* (partim), Œrsted. Entwurf Plattwür., p. 92.
„ „ „ „ Ibid. De Regionibus marin., p. 80.
1845. *Nemertes glaucus* (?), Kölliker. Verhandl. d. schweiz. nat. Gesellsch. zu Chur im Juli, 1844, p. 89.
„ *Borlasia alba,* W. Thompson. Ann. Nat. Hist., vol. xv, p. 320, with woodcut.
„ *Planaria rosea,* Ibid. Op. cit., p. 321.
1846. *Borlasia? alba,* Johnston. Ann. Nat. Hist., vol. xvi, p. 434 (Index).
„ *Prostoma lactiflorea,* Ibid. Op. cit. (Index), p. 435.
„ *Prostoma? rosea,* Ibid. Index, p. 436.
„ *Polia mandilla,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 203, tab. 8, f. 1 and 1*a*, and tab. 9, f. 2.
„ „ *mutabilis,* Ibid. Op. cit., p. 205, tab. 10, f. 2.
„ „ *violacea,* Ibid. Op. cit., p. 210.
„ „ *berea,* Ibid. Op. cit., p. 211.
„ „ *glauca,* Ibid. Op. cit., p. 206, tab. 10, f. 3.
1849. „ *mandilla,* Ibid. Voyage en Sicilie, vol. ii, p. 115, pl. 15, f. 1, A B.
„ „ *mutabilis,* Ibid. Op. cit., p. 117, pl. 15, f. 4 and 5.
„ „ *violacea,* Ibid. Op. cit., p. 122, pl. 16, f. 16, and pl. 17, f. 1.
„ „ *berea,* Ibid. Op. cit., p. 123, pl. 15, f. 13.
„ „ *glauca,* Ibid. Op. cit., p. 118, pl. 15, f. 7—9, var.
1850. *Nemertes glaucus,* Von Siebold. Archiv für Naturges., ii, p. 382.
„ „ *mandilla,* Diesing. Syst. Helm., vol. i, p. 275.
„ *Omatoplea mutabilis,* Ibid. Op. cit., p. 252.
„ „ *violacea,* Ibid. Op. cit., p. 253.
„ „ *berea,* Ibid. Op. cit., p. 252.
„ „ *glauca,* Ibid. Op. cit., p. 253.
„ „ *alba,* Ibid. Op. cit., p. 252.
1853. *Gordius albicans,* Dalyell. Pow. Creat., vol. ii, p. 73, pl. 10, f. 5*a* and 6.

1862. *Ommatoplea mutabilis,* Diesing. Revision der Turbell., p. 257.
„ „ *violacea,* Ibid. Op. cit., p. 257.
„ „ *berea,* Ibid. Op. cit., p. 257.
„ „ *glauca,* Ibid. Op. cit., p. 257, *bis.*
„ „ *alba,* Ibid. Op. cit., p. 257.
„ *Nemertes mandilla,* Ibid. Op. cit., p. 303.
„ *Borlasia mandilla,* Keferstein. Zeitsch. für wiss. Zool., Bd. 12, p. 58, Taf. 5, f. 1—7.
1863. *Ditactorrhochma mandilla,* Diesing. Nachträge zur Revis. der Turb., p. 11.
1865. *Omatoplea rosea,* Johnston. Catalogue Brit. Mus., p. 23, pl. II*a*, f. 2, 2*, 2**, 3, and 3*.
„ „ *alba,* Ibid. Op. cit., p. 23.
1865-6. *Polia mandilla,* De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 3.
1866. *Ommatoplea rosea,* Lankester. Ann. Nat. Hist., 3d Ser., vol. xviii, p. 388.
„ „ *alba,* Ibid. Op. cit., p. 388.
1867. „ „ McIntosh. Rept. Brit. Assoc., 1867; Trans. Sect., p. 92.
1868. „ „ Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. „ „ and var. *rosea,* McIntosh. Trans. Roy. Soc. Edinb., vol. 25, pt. ii, p. 323 et seq.

Habitat.—Under stones between tide-marks and in the laminarian region; abundant. Generally distributed—from the Arctic Seas probably to the Mediterranean.

Body rounded on the dorsal surface, flattened on the ventral, not much tapered towards the tail, which is rather blunt. In newly spawned specimens the body is much flattened, but in those bearing ova it is rounded. Length one to three inches, and occasionally even reaching four inches; breadth three lines.

Colour.—Various shades of white or pinkish white, with a translucent streak along the centre of the dorsum—caused by the proboscidian chamber. Specimens with the generative organs well developed assume a grayish aspect. There are two conspicuous pink or reddish-pink spots indicating the ganglia in front. The under surface has the same colour as the dorsum, and during the quiescent state of the reproductive organs is distinctly marked by the pinnæ of the digestive chamber. A specimen found at St. Peter Port, Guernsey, had the body of a pale greenish hue, like that usually seen in *Tetrastemma melanocephala*; while in the Bight of Vatsland (to the north of Bressay Sound) in Shetland a variety with the pigment everywhere increased abounds on a sandy bottom.

Head spathulate, flattened, and slightly pointed; furnished with numerous eyes placed in two or three groups on each side, the anterior generally forming a marginal row; the posterior arranged in front of or sometimes over the ganglia, and three often forming a triangle. In the pale brownish variety from Shetland an eye-speck on each side in front of the ganglia is larger and more conspicuous than the others.

Cephalic furrows.—Midway between the tip of the snout and the anterior border of the ganglia a furrow runs inwards and slightly forward on the dorsum, ceasing before it reaches the middle line. On the ventral surface is a similar though shorter furrow, the two meeting on the side at a richly ciliated dimple, which leads into the cephalic pit. A short distance behind the ganglia two other superficial furrows exist, each slanting backwards and inwards to meet its fellow of the opposite side in the middle line. These furrows are also continued inferiorly, but with a slightly altered direction, so that they meet under the ganglia. The two sets of furrows are indicated in the flattened head by lateral notches.

This is a very common animal, generally lurking under stones between tide-marks, whether these rest on sand, gravel, or sandy mud, and sometimes the latter is odoriferous; thus at Herm it frequently lives amidst crushed and blackened fragments of *Zostera marina* and sea-weeds under stones. In such situations it generally resembles in contraction a cream-coloured larva, but when placed in sea-water it readily extends itself and crawls with a slow gliding motion, and likewise progresses on the surface of the water with the ventral region uppermost. It lives well in confinement, and numerous broods can be reared from captive specimens. The white ova are deposited in a free condition from January to April, and the young are from the first furnished with two eyes. I have not been able to see this species feed in confinement, but the rapid fattening in the free condition after spawning shows that it takes nourishment greedily.

The skin presents an acid reaction to test-paper, and the mucus secreted thereby is of a most tenacious description, the animal, indeed, rapidly forming an investment by this means when placed in a vessel containing a little sand.

Considerable confusion has prevailed with regard to this very abundant and widely distributed species. Johnston, Œrsted, and others have considered the *Planaria rosea* of O. F. Müller referable to this form, but, as will be noticed elsewhere, a careful consideration of all the facts has led me to a different conclusion. When descriptions and figures are so vague and uncharacteristic, it is impossible to clear away all doubts, but such uncertainty cannot be laid to our charge. The earliest reliable account of the species is, perhaps, that given by Pallas in his 'Miscellanea Zoologica,' but the specific name (*oxyurus*) there given is objectionable, and I have consequently adopted another. Dr. Johnston, amongst modern authors, first clearly described this common worm, and since his period less difficulty has been encountered in regard to its discrimination. This author changed the name originally applied by him to the species from various causes, none of which, however, interfere with our following the usual laws of zoological nomenclature. For some time I was inclined to include the *Amphiporus albicans* of Ehrenberg under the synonyms, as it has many characters in common, but it approaches *A. pulcher* in others, and the arrangement of the eye-specks in his figure is so different that I have struck it off. For the same reason the *Planaria elongata* of Montagu (MS. p. 231) was not included. The *Polia mandilla* of De Quatrefages, from St. Vaast, probably belongs to this form, and there is nothing in the slight differences noted in *Polia mutabilis*, *P. violacea* and *P. berea* to distinguish them from the same worm. The *P. glauca* of this author is also, in all likelihood, a dark variety of the species.

2. Amphiporus pulcher (O. F. Müller), Johnston. Plate I, fig. 3, and Pl. XIV, fig. 11.

Specific character.—Eyes well-defined and numerous, irregularly grouped on each side. A central reserve-stylet in the proboscis. Cephalic furrows slightly branched.

Synonyms.

1774. *Fasciola rosea,* O. F. Müller. Verm. terrest. et fluv. hist., i, 2, p. 58.
1776. *Planaria rosea,* Ibid. Zool. Danic. Prodr., p. 221, No. 2679.
1788. „ „ Ibid. Zool. Danic., ii, p. 31, tab. 64, f. 1 and 2.

1788. *Planaria rosea,* Linnæus. Syst. Nat. (Gmelin's), tom. i, pars vi, p. 3088.
1827. „ „ Bosc. Hist. Nat. des Vers., i, p. 256.
1837. *Nemertes pulchra,* Johnston. Mag. Zool. and Bot., vol. i., p. 536, pl. 17, f. 6.
„ *Polystemma roseum,* Œrsted. Kroyer's Nat. Tids., iv, p. 579.
„ „ *pulchrum,* Ibid. Ibid., p. 580.
1844. „ „ Œrsted. Entw. Plattw., p. 93.
1846. *Prostoma pulchra,* Johnston. Ann. Nat. Hist., vol. 16, p. 436.
1850. *Omatoplea rosea* (partim), Diesing. Syst. Helm., vol. i, p. 251 et postea.
„ „ *pulchra,* Ibid. Ibid., p. 252.
1853. *Vermiculus rubens,* Dalyell. Pow. Creat., vol. ii, p. 89, pl. 10, f. 13—18.
1862. *Ommatoplea pulchra,* Diesing. Revis. der Turbell., p. 257.
1865. „ „ Johnston. Catalogue Brit. Mus., p. 24, pl. ii *a*, f. 6 and 6*.
1866. „ „ Lankester. Ann. Nat. Hist., 3rd ser., vol. 17, p. 388.
1868. „ „ McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
„ „ „ Ibid. Rept. Brit. Assoc., 1868, p. 340.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. 25, pt. ii, p. 337 et seq.

Habitat.—Generally diffused round the British coasts in water eight to thirty fathoms deep, and specimens were dredged by Mr. Jeffreys off Unst, Shetland, even at a depth of 120 fathoms. It frequently occurs amongst shells and other débris brought from the coralline region by the fishermen.

Body one to three inches and a half long, and three to five lines broad; flattened, thinned at the edges, slightly narrowed behind the snout; of nearly equal diameter throughout the middle region when stretched, but the anterior part is often narrowed, while the posterior forms a broad flattened oar. In extreme contraction, the body resembles an *Elysia* or *Limapontia,* or even becomes baccate.

Colour.—During the period of reproductive quiescence the animal has a general dull pinkish hue, pale at the snout, along the margins, and at the tail. The pinkish tint proceeds forward in the centre of the snout in front of the ganglia. The under surface is pale pinkish. In the ripe females the lateral regions are enlivened by the rich reddish hue of the ova, which shine through the transparent integuments, so that, from their somewhat symmetrical disposition, the animal has a segmented appearance, from the termination of the œsophageal region nearly to the tip of the tail. In specimens which have lived a considerable time in captivity the dorsum becomes freckled with brownish-red grains, especially towards the snout.

Head broadly spathulate, pointed at the tip, flattened; the snout clearly defined from the rest of the body by a well-marked furrow, which notches each side, and passes inwards almost to the middle line. The tip is furnished with a distinct central papilla, from which an opaque line generally proceeds backwards to the central glandular mass. Some distance behind the transverse furrow another oblique groove coming from the ventral surface slants backwards and inwards—meeting its fellow of the opposite side in the middle line of the dorsum, so as to form an acute angle. There are numerous large, well-defined eyes, which form somewhat irregular groups on each side, to the number of about twenty-three in all, three or four lying behind the transverse furrow. These are much more distinct in some specimens than in others. On the under surface the furrows are continued straight inwards towards a dimple (Plate XIV, fig. 11), then curve forward and inwards to the middle line. Numerous longitudinal grooves slant from the front towards these furrows so as to produce a similar appearance to that in *Amphiporus spectabilis*, Quatref., but less marked in the lateral regions. The ganglia lie quite behind the transverse furrow, as indicated by the shading in the figure.

This species is often found in crevices of the coils of *Serpulæ* attached to shells and stones from deep water, and it is one of the most interesting of the group. It glides over the bottom of the vessel with considerable speed, almost without a wrinkle of its body; and when irritated a healthy example turns on its edge, and, by swift lateral strokes of the oar-like posterior extremity, swims rapidly through the water like a *Nephelis* or a horseleech, so that not infrequently the uninitiated mistake it for a species of the latter. In contraction the head is drawn within the anterior portion of the body, the neck forming a kind of collar through which the organ slips inwards.

It rapidly secretes a tough sheath of transparent and iridescent mucus, under which it remains for days. The skin presents an alkaline reaction to test-paper.

The ova are developed in the beginning of May and are nearly ripe towards the end of June, but though many ova have been discharged in the vessels, I have hitherto been unable to watch their development.

While, for a time, of opinion that the *Planaria rosea* of O. F. Müller (' Zool. Danica') might refer either to this or the previous form, I now think that in all probability this species has the preference in the description and figure. He says, "Body elongate, sub-equal, convex above, of a rosy colour, marked with black points and lines (not distinct in some); flat beneath, of a pale red interrupted with transverse striæ, posterior end blunt, anterior produced into an angular head; the latter is marked on each side by a semicircle of black points." The figure (which has its anterior end downwards) bears a considerable resemblance to this form, especially in the head and position of the eyes. His remark, however, that it is common everywhere leaves a certain degree of doubt, and I have therefore chosen Dr. Johnston's title. The latter author was the first to give a proper account of the species, from specimens procured amongst corallines and old shells in deep water off the coast of Berwickshire. He noted the appearance of the ova in the female, describing them as a series of bright scarlet spots along the sides. Sir J. Dalyell mentions a stripe, generally yellowish, which runs down the back, and a broader stripe along the ventral surface, but these probably refer to the colour of the digestive canal. Fair figures of the structure of the proboscis and the external appearance of this species are present in Gaimard's ' Voyages en Scandinavie, en Laponie,' as mentioned in the zoography.

I have not thought it necessary to include all the synonyms given by Œrsted and Diesing, since it is doubtful to what species they refer.

3. Amphiporus spectabilis, De Quatrefages. Plate III, figs. 2, 7, and 8.

Specific character.—Head spathulate, peculiarly narrowed posteriorly. Eyes in two long rows on each side. Cephalic furrows conspicuously branched. Longitudinally striped with brown on the dorsum.

SYNONYMS.

1846. *Cerebratulus spectabilis,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., p. 219, tab. 10, f. 7.
1849. ,, ,, Ibid. Voyage en Sicilie, vol. ii, p. 131, pl. 17, f. 12 and 13.
1850. *Nemertes spectabilis,* Diesing. Syst. Helm., vol. i, p. 272.
1852. *Cerebratulus spectabilis,* Max Schultze. Zeitsch. f. wiss. Zool., Bd. iv, p. 183.
1861. ,, ,, Grube. Ein Ausflug nach Triest, &c., pp. 80 and 129.
1862. *Nemertes spectabilis,* Diesing. Revision der Turbell., p. 299.
,, *Borlasia splendida,* Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 59, taf. v, f. 10—18.
1863. *Ptychodes splendida,* Diesing. Nachträge zur Revis. der Turb., p. 12.
1864. *Cerebratulus spectabilis,* Grube. Die Insel Lussin u. ihre Meeresf., p. 94.
1869. *Cerebratulus* (*Ommatoplea*) *spectabilis,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, pp. 342 and 355.

Habitat.—Dredged off St. Peter Port, Guernsey, at a depth of 18—20 fathoms, in a fissure of *Eschara foliacea.* Sicily, the Adriatic and St. Vaast-la-Hougue; generally in the crevices of shells.

Body rather more than three inches in length, and about a fifth of an inch in breadth, flattened; dilating rather abruptly behind the snout, and again diminishing towards the tail. The margins are thin.

Colour brownish, with six longitudinal brown stripes on the dorsum, and five pale intermediate lines. The two bands on each side of the central line are somewhat dark in colour, wide in front, narrow and somewhat closely applied posteriorly. The two adjoining brown belts become considerably wider towards the tail. Besides the foregoing there is also a marginal brown stripe, which is somewhat wider posteriorly. The tip and edges of the snout are pale, the four central brown bands of the dorsum being continued thereon, the two lateral becoming indistinct over the pigmentary region, the two central almost reaching the tip of the snout. All the four stripes are much narrowed and more closely approximated after passing the cephalic furrows, and the two lateral are in addition bent inwards towards the middle line at the latter. The under surface has a uniform pinkish colour, slightly marked within each border by a reddish coloration from the vessel.

Head narrower than the rest of the body, somewhat conical, defined posteriorly by a very distinct notch on each side. The region assumes various shapes according to the motions of the animal, sometimes presenting a blunt tip with a notch in the centre and almost cylindrical, at others a dilated tip and a constricted posterior portion. In the recently captured animal the eye-specks are not very evident on the dorsum, but after it has been blanched by captivity, they are observed to form two rows on each side, the central having about ten eye-specks, and the lateral a larger number. The former are best seen on the dorsal, the latter on the ventral surface, or from the side, and they proceed further forward than the central, indeed, almost to the tip of the snout. In the inner rows the eyes are nearly equal in size, while in the outer there are some larger ones towards the front.

Cephalic furrows.—From the notch, which on each side marks the posterior boundary of the snout, a well-marked furrow proceeds inwards and backwards, and is joined by eight or nine deep grooves which occupy the slightly dilated region immediately in front of the oblique furrow. These accessory grooves have in general a longitudinal direction, but they are curved in various ways, and are of different lengths. On the under surface of the snout the lateral furrow follows a different course, being directed forward and inward on each side.

This animal lives well in confinement; the sole specimen procured at Guernsey in the end of July survived till the middle of November. At this time it discharged a vast number of ova and perished in their midst, so that the effort of spawning had been too much for its health, or the water had become vitiated by the fluids exuded during the process. When irritated it swam rapidly through the water like *A. pulcher*, but generally lay quiescent on the bottom of the vessel surrounded by a delicate mucous investment, the body being shortened and thickened, but the head narrow and papilliform.

It has strictly the structure of the *Amphiporidæ*, the longitudinal bands of the reticulated layer of the pinkish proboscis being very apparent. The blood is reddish-pink.

The species was first described in a recognizable manner by M. de Quatrefages, and though his drawing of the complete animal and its head are not quite accurate, their identity is satisfactorily made out. He does not say anything about the blood of this form, but he mentions that in *Cerebratulus crassus* it is reddish, and this with other points at one time inclined me to unite the species. The arrangement of the eyes is, at any rate, very similar, and if more pigment is added to the dorsum of the present form, the distinction only rests on the author's account of the stylets, on which comparatively little reliance can be placed. It was erroneously described as a new species by the lamented Prof. Keferstein under the name *Borlasia splendida*, and as having the mouth behind the ganglia; but he correctly interpreted the structure of the stylet-region of the proboscis. Prof. Grube accepted the anatomy given by M. de Quatrefages, and did not dissect the animal himself.

The *Polia pusilla* of Delle Chiaje (Descrip. e Notom., &c., tom. iii, p. 126, tav. 103, figs. 13—15) is a closely allied species.

Amphiporus hastatus, n. s. Plate VIII, fig. 2.

Specific character.—Snout not wider than the succeeding portion of the body, with a grooved median ridge; ungulate when viewed laterally, hastate when seen from the dorsum. Eyes somewhat indistinct. Brownish yellow, with white grains on the snout.

Habitat.—In seven fathoms Bressay Sound, Shetland, amongst tangle-roots attached to horse-mussels.

Body about an inch and three fourths long, and a seventh of an inch broad, rather rounded, gently dilating from the snout backwards, a slight diminution only occurring at the tail, which is thick and broad. The edges of the body are not thinned off, as in *A. pulcher* and others.

Colour pinkish; very much resembling that variety of *A. lactifloreus*, the hue being deepest in front, behind the reddish spots caused by the ganglia. The snout is paler than the subsequent portion of the body, and shows a series of whitish grains on the upper surface. The proboscis and proboscidian fluid are visible in the median line of the body. The mouth (woodcut, fig. 9) has some grayish-brown pigment-grains along its margins, and there is a curved band of the same hue a little behind the tip of the snout on each side.

The under surface of the body is generally paler than the upper.

Head with a snout narrower than the succeeding portion; bluntly pointed, and similar in shape to the head of a short spear or harpoon. In the median line is a grooved ridge, which, although cut by the cephalic furrow, is continued some distance along the dorsum of the body. On each side of the ridge is a longitudinal hollow on the snout. The eye-specks are placed a little behind the tip of the latter, and from their deep situation are somewhat indistinct. When viewed laterally the peculiar tapering of the snout resembles the hoof of a horse. The mouth is marked on the under surface, either as a slit like a key-hole, or as a linear depression (fig. 9)—rendered conspicuous by its pigment, according to the degree of contraction: in few species, indeed, is it so well seen.

Fig. 9.

Under surface of the anterior region of *Amphiporus hastatus.* Somewhat enlarged.

Cephalic furrows.—At the posterior border of the snout a well-marked groove proceeds inwards and slightly forward on each side to the median ridge, where a Λ-shaped process is formed by a sudden turn of the furrow inward and forward. The groove is continued on the ventral surface in a similar manner, and also has a slightly developed median angle at the mouth.

This curious form combines the hardihood of *A. lactifloreus* with the irritability of *A. pulcher*. It is exceedingly contractile, becoming quite baccate when stimulated; the head being withdrawn through a collar of the body, as in the latter species. The grooves of the snout during the various movements become much exaggerated, and give the animal a very characteristic appearance. In minute anatomy it belongs strictly to the *Amphiporidæ*, the large proboscis, moreover, being furnished with four marginal stylet-sacs.

Amphiporus bioculatus, n. s. Plate VIII, fig. 3.

Specific character.—Dull orange; snout acutely pointed, with a distinct cephalic furrow forming an angle directed forward at its posterior boundary. Eyes two, placed at the extreme tip of the snout.

Habitat.—Amongst tangle-roots attached to horse-mussels, in eight fathoms, Bressay Sound, Shetland.

Body about an inch in length, and rather more than a line in breadth, rounded, increasing in diameter from the pointed snout almost to the posterior third. The tail is rather blunt.

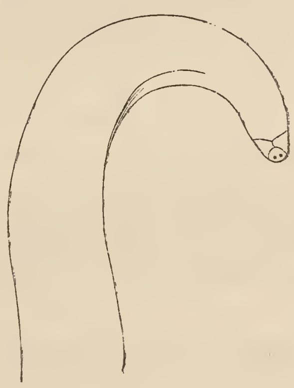
Colour dull orange, or pale brownish, inclining to reddish in front, especially in the region of the snout. Under surface somewhat pale.

Head with a small, pointed snout, which is bounded posteriorly by an angular furrow (woodcut, fig. 10). The mouth is indicated on the ventral surface by a streak running forward from the arch of the latter (woodcut, fig. 11). Two eyes, consisting of simple masses of black pigment, are observed at the tip of the upturned snout (woodcut, fig. 10).

Cephalic furrows.—Viewed from the dorsum the furrow passes from each side of the snout inwards and forward, so as to form an angle. On the ventral surface, again, it makes an arch with the convexity directed forward, the slit for the mouth springing from the centre. The course of the dorsal and ventral furrows is such that when the snout is seen in profile, a somewhat acute angle is formed at their junction on the side.

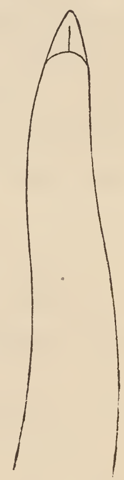
This is another interesting species supplied by the rich tangle-roots on the mussel-ground of

Fig. 10.



Outline of the anterior dorsal region of *Amphiporus bioculatus.* Enlarged.

Fig. 11.



Ventral surface of the anterior region of *A. bioculatus.*

Bressay Sound. It lives well in confinement, and it can be observed that, instead of the usual gliding progression of its allies, this form moves its snout in a boring manner.

The specimens were loaded with fully-developed spermatozoa in the beginning of August.

Genus II.—Tetrastemma,[1] *Ehrenberg,* 1831.

Like many others of the race, the species of this genus were included amongst the *Fasciolæ* by O. F. Müller, the first who, in the 'Zoologica Danica,' clearly described a species (*Fasciola candida*). Ehrenberg, in establishing his genus *Tetrastemma,* in 1831, seized upon a very constant character; but we must dissociate it from many of the genera which formed along with it the anomalous Family Gyratricina. Though he describes the proboscis as being exserted from a transverse fold of the snout in his typical species, and hence apparently connecting it with Keferstein's *Prosorhochmus,* an attentive examination of the other parts of his description and his figures has convinced me that he alludes to a form identical with one not uncommon in Britain, viz., *Tetrastemma flavida.*

Generic character.—Eyes four; arranged so as to indicate a square or oblong.

[1] Τετρὰς, four, στέμμα, a crown.

1. Tetrastemma melanocephala, *Johnston*. Plate II, fig. 1.

Specific character.—A large mass of black pigment between the eyes. Marginal stylet-sacs placed considerably in front of the central apparatus.

Synonyms.

1808. *Planaria unipunctata,* Montagu. MS., p. 236, tab. 55, f. 5.
1837. *Nemertes melanocephala,* Johnston. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 5.
1842-3. „ „ Œrsted. Kroyer's Naturhist. Tidskr., iv, p. 577.
1844. „ „ Ibid. Entwurf. Plattw., p. 88.
1846. *Prostoma melanocephala,* Johnston. Ann. Nat. Hist., vol. 16, p. 436.
„ *Nemertes melanocephala,* W. Thompson. Ann. Nat. Hist., vol. xviii, p. 387.
„ *Polia coronata,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 213.
„ „ *pulchella,* Ibid. Op. cit., p. 214.
1849. „ *coronata,* De Quatrefages. Voyage en Sicilie, vol. ii, p. 125, pl. 13, f. 6—9.
„ „ *pulchella,* Ibid. Op. cit., p. 126, pl. 16, f. 7 and 8.
1850. *Œrstedia pulchella,* Diesing. Syst. Helm., vol. i, p. 248.
„ *Nemertes melanocephala,* Ibid. Op. cit., p. 270.
„ „ *coronata,* Ibid. Op. cit., p. 271.
1859. *Loxorrhochma coronatum,* Schmarda. Neue wirb. Thiere, I, i, p. 39.
1862. *Tetrastemma menalocephalum,* Diesing. Revis. der Turbell., p. 291.
„ *Loxorrhochma coronatum,* Ibid. Op. cit., p. 295.
1865. *Omatoplea melanocephala,* Johnston. Catalogue Brit. Mus., p. 23, pl. IIa, f. 5 and 5*.
1866. „ „ Lankester. Ann. Nat. Hist., 3rd ser., vol. 17, p. 388.
1867. *Cephalotrix unipunctata,* Parfitt. Catal. Annel. Devonsh., p. 5.
„ *Omatoplea melanocephala,* Ibid. Ibid., p. 7.
1868. *Ommatoplea* „ McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 333 et seq.

Habitat.—Under stones between tide-marks, in crevices of rocks near low-water mark, and ranging to twenty fathoms off Guernsey. Coast of France, and Sicily.

Body two to two and a half inches in length, somewhat flattened in progression, rounded in contraction, gently dilating behind the head, then continuing of almost equal calibre until near the tail.

Colour dull yellow, greenish yellow, or dull green; occasionally with minute brownish pigment-grains along the sides. A large and somewhat quadrate black patch on the snout, in some cases with one faintly marked band of white pigment in front, and another—more distinct—posteriorly. In a specimen from deep water off Guernsey the dark spot on the head was nearly invisible, and the whitish pigment indistinct. The fluid in the proboscidian sheath causes a pale streak along the centre of the dorsum.

Head flattened, much wider than the succeeding portion of the body, furnished with a notch in front. The first two eyes are placed some distance behind the tip of the snout, and incorporated with the anterior border of the black patch, so that they are not at first observed. The posterior eyes lie quite behind the pigment-patch, the white band, when present, intervening.

The pairs are equidistant. Rarely the single specks are represented by two or three smaller pigment-patches.

Cephalic furrows.—An oblique furrow runs from the margin on each side inwards and backwards towards the posterior eye, and behind the latter two other grooves meet at an angle, as in *A. lactifloreus*, in the middle line of the dorsum. On the under surface of the snout a furrow passes from the cephalic pit inwards on each side; and there is a continuation of the posterior furrows, as in the last-mentioned form.

It is less hardy than *A. lactifloreus* in confinement, but can readily be kept several months. It remains chiefly at the water-line in a silky sheath of the tough transparent mucus. Almost every specimen in the free state in the Channel Islands was furnished with the latter, though the case was less transparent on account of the adherent débris. The skin gives an acid reaction to test-paper.

I have not yet seen a specimen of this species with ova or spermatozoa, so that it must breed very late or very early. The young soon acquire the black patch on the snout, and other characteristics. It was absent from the rocks at St. Andrews in April and May.

This species was first discriminated by Col. Montagu under the name *Planaria unipunctata*, though Dr. Johnston's title has the priority by publication. The former described the species, which he procured on the south coast of Devonshire, as follows:—"Body filiform, with a black subquadrangular spot that nearly covers the head, behind which are two minute black eyes, distant from each other." The *Planaria ascaridea* of the same author had the "body long, linear, white, with a square black spot close to the anterior end," and in all probability is to be referred to the same species. Length one inch. Moreover, though he describes the square black spot of *Planaria filum* as situated between the pairs of eyes, this too can scarcely be any other animal than that now under discussion. Œrsted remarks that there is a transverse brown bar between the eyes of his *Tetrastemma rufescens*, but there is no other character to connect it with this form. It is probable Professor Kölliker refers to the same species under the name *Nemertes Knochii* (*Krohnii?*), as he describes a transverse brownish-red band of pigment on the head. There is no doubt of the identity of the present species with the *Polia coronata* of M. de Quatrefages, from Bréhat, though his figure of the head is faulty, and the colour peculiar, since he states that the spot between the eyes has a violet hue. The *Polia pulchella* of the same author, from Sicily, seems to be a greenish variety, in which the pigment-patch on the head is separated from the eyes in front and behind by a larger interval than usual.

2. Tetrastemma robertianæ, n. s. Plate III, fig 1.

Specific character.—Anterior pair of eyes larger than the posterior, which are sometimes quite hidden in the pigment-belt; body longitudinally striped with two brown and a median white line.

Habitat.—Dredged in four fathoms in Lochmaddy amongst tangles, and from the roots of the same seaweeds in Bressay Sound at a depth of six to eight fathoms.

Body about $1\frac{1}{8}$th inch long, flattened, rather narrowed in front, then gently dilating towards the tail, which is slightly tapered, and furnished with a somewhat thin margin.

Colour a uniform dull pinkish or pinkish-brown, marked on the dorsum by three stripes—a central white and two lateral brown belts. The latter commence at a ring of the same colour which surrounds the posterior boundary of the snout, and proceed backwards to the tail, where they join; and the central white line follows a similar course. They are not close to each other, but a stripe of the usual ground-colour of the dorsum intervenes. The abdominal surface has a pale pinkish-brown hue throughout, with the exception of the ventral portion of the brown ring in front.

Fig. 12.

Dorsal view of the anterior region of *Tetrastemma Robertianæ.* Enlarged.

Head wider (in its greatest transverse diameter) than the succeeding portion of the body, spathulate, furnished with four black eyes, the anterior pair of which is the larger, while the posterior specks are closer and just in front of the transverse pigment-belt. The mouth is a well-marked longitudinal slit, in the usual position on the ventral surface.

Cephalic furrows.—These pass inwards and backwards from the prominent angles of the snout on the dorsum towards the posterior pair of eyes. The lateral notch is seen on the ventral surface, but the direction of the furrows thereafter (if such exist) is indistinct.

In a pale example from Shetland the brown ring anteriorly appears only on the dorsum, and the central white line is somewhat faint. In the coloured drawing (Plate III, fig. 1) only two eyes are visible, the posterior pair being covered by the great development of the pigment-belt. The ordinary condition is represented in the woodcut fig. 12.

Œrsted describes a *Tetrastemma bioculata,* but the snout in his species is peculiarly acuminate, and he indicates no stripes or other colouring of note.

3. Tetrastemma candida, *O. F. Müller,* 1774. Plate II, figs. 2 and 3.

Specific character.—Head flattened, wider than the rest of the body; eyes distinct. Stylets large. Colour pale yellow, greenish, or reddish.

Synonyms.

1774. *Fasciola candida,* O. F. Müller. Verm. terrest. et fluv. hist., I, ii, p. 71.
1776. *Planaria candida,* Ibid. Zool. Dan. Prodr., p. 223, No. 2704.
1780. „ „ O. Fabricius. Fauna Grœnlandica, p. 327.
1788. „ „ Linnæus (Gmelin). Syst. Nat., tom. i, pars vi, p. 3094.
1798. „ „ O. Fabricius. Skrivt. af Naturhist. Selskab., iv, p. 62, tab. 11, f. 11.
1828. „ „ Bosc. Hist. Nat. des Vers., i, p. 262.
1829. *Planaria quadrioculata,* Johnston. Zool. Jour., vol. iv, p. 56.
1837. *Nemertes quadrioculata,* Ibid. Mag. Zool. and Bot., vol. i, p. 535, pl. 17, f. 4.
„ *Tetrastemma varicolor* (partim), Œrsted. Kroyer's Naturhist. Tids., iv, p. 575.
1844. „ *candidum,* Ibid. Entw. Plattw., p. 88.
„ „ *varicolor* (partim), Ibid. Op. cit., p. 85, f. 41 and 44.
„ „ „ Ibid. De Region. marin., p. 79.

1846. *Prostoma quadrioculata,* Johnston. Ann. Nat. Hist., vol. xvi, p. 436.
„ *Polia quadrioculata,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 216, pl. 11, f. 1.
1847. „ „ Frey u. Leuckart. Beiträge z. Kennt. wirb. Thiere, p. 150.
1849. „ „ De Quatrefages. Voyage en Sicilie, vol. ii, p. 128, pl. 16, f. 10 and 11.
1850. *Tetrastemma varicolor,* Diesing. Syst. Helm., vol. i, p. 257.
„ „ *grœnlandicum,* Ibid. Op. cit., p. 259.
„ „ *Krohnii,* Siebold. Archiv für Naturges., ii, p. 382.
1851. „ *varicolor,* Maitland. Descrip. syst. anim. Belg. septent., p. 190.
1853. *Vermiculus coluber?* var., Dalyell. Pow. Creat., vol. ii, p. 91, pl. 10, f. 24.
„ *Planaria algæ,* Ibid. Op. cit., p. 117, pl. 16, f. 24 and 25.
1858. *Polia quadrioculata,* Williams. Philos. Trans., 1858, p. 131.
1859. *Tetrastemma algæ,* Leuckart. Archiv für Naturges., ii, p. 188.
1860. *Polia obscura* (partim), Van Beneden. Mém. Acad. Belg., tom. xxxii, p. 23, pl. 4, f. 2, 4, &c.
„ „ *capitata,* Ibid. Op. cit., p. 28, pl. 4, f. 12, &c.
„ „ *farinosa,* Ibid. Op. cit., p. 29, pl. 4, f. 17.
1861. *Tetrastemma varicolor?* Claparède. Recher. Anat. sur les Annél. Turb., &c., p. 81, pl. 5, f. 6.
1862. „ „ (partim), Diesing. Revis. der Turbell., p. 289.
„ „ *obscurum* (partim), Ibid. Op. cit., p. 291.
„ „ *capitatum,* Ibid. Op. cit., p. 292.
„ „ *grœnlandicum,* Ibid. Op. cit., p. 293.
„ „ *farinosum,* Ibid. Op. cit., p. 293.
„ *Loxorrhochma obscurum,* Ibid. Op. cit., p. 295.
1863. *Tetrastemma varicolor,* Diesing. Nachträge zur Revis. der Turbell., p. 10.
„ „ *algæ,* Ibid. Op. cit., p. 11.
1864. *Polia quadrioculata,* Grube. Die Insel Lussin u. ihre Meeresf., p. 96.
1865. *Tetrastemma varicolor* (partim), Johnston. Catalogue Brit. Mus., pp. 20 and 289.
„ „ *algæ,* Johnston. Op. cit., p. 20.
1865-6. *Polia quadriocellata,* De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 2.
1869. *Tetrastemma algæ,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

Habitat.—Not uncommon under stones near low-water mark, especially amongst the algæ and corallines which cover their surfaces, and, indeed, one of the best modes of procuring the species is to immerse portions of such stones in sea-water, when the animals seek the water-line and are easily observed. It extends from the Shetland to the Channel Islands.

Body one to one and a half inch long, and nearly a line in breadth; somewhat flattened, narrowed behind the head, and again tapered towards the tail.

Colour.—Various shades of grass- or siskin-green, but females bearing ova have a dull grayish aspect. Some varieties, also, are pale yellow. The head is usually paler than the rest of the animal. Two dull red spots indicate the ganglia. A Zetlandic variety occurs in Bressay Sound of a reddish-brown colour, and in some a few white grains are situated between the anterior pair of eyes.

Head much flattened, spathulate, wider than the succeeding portion of the body, with a pale streak in the median line anteriorly, where there is also a slight notch. Eyes four, forming a square; by the lengthening of the snout, however, they are placed at the corners of an oblong.

Cephalic furrows.—The two oblique anterior furrows course inwards near the posterior pair of eyes, and cause a notch at the margin of the snout in front of the latter. The posterior pair were only examined in small examples, and they were very indistinct, but they probably have the same direction as in other species.

A variety was dredged off St. Peter Port, Guernsey, in 10 fathoms, with the eyes of large size, very pale, and with whitish grains from the tip of the snout backwards between the pairs. The stylet-region had the posterior border of the muscular investment nearly transverse, but probably this was abnormal, as in all other respects it agreed with that of *T. candida.*

This is a very restless species, constantly gliding about with considerable speed; indeed, it is one of the most active of the group. It is tolerably hardy, and will survive more than twenty-four hours on a moist stone in a room. In Bressay Sound the variety above mentioned abounds amongst *Obelia geniculata* about half-tide mark, as well as amongst *Corallina* bored by *Leucodore* at the extreme verge of high-water.

Whether the variety shown in Plate III, fig. 5, and having a pale orange hue, will prove to be specifically different on further investigation, I am at present unable to say, as the drawing was the sole remembrance brought by my sister in one of her excursions. It was procured from the deep water off St. Andrews Bay.

The ova are developed in April and May, as well as in autumn.

I am inclined to refer the *Fasciola candida* of O. F. Müller to this common and variable form. It was discovered by O. Fabricius under stones on the shores of Greenland, and his specimens were unusually large, viz. from two to three inches, the only doubtful feature in the description. Œrsted's *Tetrastemma varicolor*, again, seems to include both this species and *T. dorsalis.* The occurrence of a single stylet-sac in the example of M. de Quatrefages is purely accidental. The *Vermiculus coluber* of Sir J. Dalyell is probably a pinkish variety of this form, and not *T. melanocephala.* M. van Beneden included this along with others under his *Polia obscura*, and the *Polia farinosa* of the same author presents no feature different from the young of this species. M. Claparède's *T. varicolor* comes under the same head, a view supported by his figure of the stylet-region. This is the only Nemertean mentioned in Maitland's 'Fauna Belgii septentrionalis.'

4. Tetrastemma vermicula, *De Quatrefages.* Plate III, fig. 3.

Specific character.—A longitudinal dark patch between the eyes of the respective sides.

Synonyms.

1846. *Polia vermiculus*, De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 214.
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 126, pl. 14, f. 12 and 13.
1850. *Nemertes vermiculus*, Diesing. Syst. Helm., vol. i, p. 270.
1862. *Tetrastemma vermiculus*, Ibid. Revis. der Turbell., p. 290.
1869. „ „ McIntosh, Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

Habitat.—Not uncommon under stones between tide-marks, and occasionally dredged in the laminarian region, from the North of Scotland to the Channel Islands. Coast of France (Bréhat).

Body.—Three fourths to one inch in length, and about a line in breadth, moderately elongated, dilating very gradually behind the head, continuing for some distance of considerable diameter, and again diminishing towards the tail.

Colour.—Dull whitish, salmon, or pinkish, with two elongated dark spots on the head. In a specimen from St. Peter Port, Guernsey, the digestive tract was pale siskin-green. There was also a faint white streak on the middle of the dorsum, commencing between the posterior pair of eyes, and proceeding a short distance backwards.

Head wider than the succeeding portion of the body, flattened, having its greatest diameter in the middle, and marked by the cephalic furrows. Eyes four, the pairs separated by a considerable interval, which on each side is nearly filled up by a longitudinal patch of dark pigment. The latter is widest anteriorly, and often does not quite reach the posterior eye, which is thus prominent, while the anterior is indistinct. There is sometimes an opaque whitish patch between the anterior pair of eyes, and this is continued faintly along the central streak.

Cephalic furrows.—A little in front of the posterior pair of eyes is the groove connected with the cephalic pit, which (furrow) passes inwards and slightly backwards on each side and soon terminates. Somewhat behind the posterior pair of eyes another furrow slants inwards and backwards, and meets its fellow of the opposite side in the middle line.

T. vermicula in its lively and restless habits much resembles *T. candida.* Many perish by crawling out of the water and being dried on the side of the vessel.

The ova are deposited in a free condition about the beginning of May.

I have placed this pretty species under the name of M. de Quatrefages, but with amended characters. He erroneously states that the head is not distinguished from the rest of the body, and that the marginal stylet-sacs are situated on the "dorsal and ventral" aspects of the proboscis. His figure, also, of the entire animal is too elongated, and his remark that the pigment-patch between the eyes of each side is violet can only refer to the aspect under transmitted light. Stimpson has a *Tetrastemma* (?) *vermiculus* in his 'Prodromus' (ii, p. 19), but its identity with the present form is doubtful.

5. Tetrastemma flavida, *Ehrenberg*. Plate IV, fig. 1.

Specific character.—Head not wider than the rest of the body. Anterior and posterior pairs of eyes widely separated.

Synonyms.

1831. *Tetrastemma flavidum,* Ehrenberg. Symb. Phys., Phyt. Turb., No. 25, tab. 5, f. 3, *a—d,* and *a*—c**.

1844-5. „ *longecapitatum,* Œrsted. Kroyer's Naturhist. Tids., i, p. 418.

„ „ *flavidum,* Ibid. Op. cit., iv, p. 576, in note.

„ „ „ Ibid. Entwurf Plattw., p. 87.

1846. *Polia sanguirubra,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 208, tab. 11, f. 3 and 7; tab. 12, f. 1.

1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 120, pl. 15, f. 11 and 12.

1850. *Tetrastemma flavidum,* Diesing. Syst. Helm., vol. i, p. 257.
„ *Nemertes hæmatodes,* Ibid. Op. cit., p. 270.
1860. *Polia obscura* (partim), Van Beneden. Mém. Acad. Belg., tom. xxxii; Recher. sur les Turb. (sep. copy), p. 23, pl. 4, f. 10.
1862. *Tetrastemma flavidum,* Diesing. Revis. der Turb., p. 289.
„ „ *sanguirubrum,* Ibid. Op. cit., p. 290.
„ „ *longecapitatum,* Ibid. Op. cit., p. 293.
1869. „ *varicolor,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

Habitat.—Under stones between tide-marks and in fissures of rocks; less common than *T. candida.* From Scotland to the Red Sea.

Body one to one inch and a half in length, attenuated, flattened, nearly of equal diameter throughout, except where slightly tapered towards head and tail.

Colour pinkish or pale peach, from the hue of the digestive tract. The snout is translucent, with a slight opacity between and rather in front of the posterior pair of eyes, and a pale patch from the ganglia behind them. The lateral margins are pale.

Head rather indistinctly defined, bluntly rounded at the tip, from the centre of which the usual pale streak proceeds. The eyes are equidistant in each pair, and the latter are separated from each other by a much longer interval than exists in *T. candida* and the others. The anterior eyes have the larger masses of pigment.

Cephalic furrows.—The openings of the cephalic sacs are placed nearly opposite the first pair of eyes, so that the anterior furrows are carried far forward. They slant inwards and backwards just behind the eyes, while inferiorly they are nearly transverse. The posterior furrows lie a little behind the last pair of eyes, and, proceeding inwards and backwards, meet in the centre of the dorsum. They have a direction forward and inwards on the inferior surface, but less obliquely than on the dorsum; thus, while the dorsal meet towards the posterior part of the ganglia, the ventral coalesce near the anterior border of the latter. The two sets of furrows are indicated by lateral notches.

This species is more sluggish than *T. candida,* and much more delicate. It resembles *Nemertes carcinophila* in the slow, gliding manner in which it moves about the vessel, a very gentle undulatory motion of the head and body taking place.

The ova are developed in May.

Prof. Ehrenberg first gave a description and drawing of this species. The equidistant eyes, with the pairs widely separated, and the cephalic furrows passing inwards nearly opposite the first pair, are fairly represented. The *Tetrastemma assimile* of Œrsted, no doubt, has the anterior and posterior pairs of eyes widely removed, but this is the only character which can be identified with the present species. The *Polia sanguirubra* of De Quatrefages, again, appears to be a variety with tinted nuclei to the proboscidian discs (a phenomenon probably due to refraction of the rays of light), and the Sicilian *Polia baculus* of the same author differs only in the somewhat more attenuated condition of the snout. His *Polia armata* is also closely allied in external characters, but the presence of four stylet-sacs, if not accidental, is a distinguishing feature. Two of these marginal stylet-sacs, according to this author, occur a considerable way in front of the central stylet, or at the anterior part of the elongated stylet-region, and two behind, opposite the basal apparatus of the central organ. M. van Beneden seems to have included specimens of this species under his *Polia obscura.* In the absence of more definite characters I have not thought it proper to place the *Tetrastemma sanguirubra* of Stimpson amongst the synonyms.

6. Tetrastemma dorsalis, *Abildgaard.* Plate I, fig. 4, and Plate III, fig. 4.

Specific character.—Body short, thick and round, little tapered towards either extremity. Speckled with yellow and brown, or with a single dorsal stripe.

Synonyms.

1806. *Planaria dorsalis,* Abildgaard. Zool. Danic., vol. iv, p. 25, tab. 142, f. 1—3.
1844. *Tetrastemma fuscum,* Œrsted. Kroyer's Naturhist. Tids., iv, p. 575.
„ „ „ Ibid. Entw. Plattw., p. 86, woodcut 14.
„ „ „ Ibid. De Region. Marin., p. 79.
1846. *Œrstedia maculata,* De Quatrefages. Ann. des sc. nat., 3^{me} sér., Zool., tom. vi, p. 222, tab. 8, f. 2.
„ „ *tubicola,* Ibid. Op. cit., p. 223.
1849. „ *maculata,* Ibid. Voyage en Sicilie, vol. ii, p. 134, pl. 17, f. 15—17.
„ „ *tubicola,* Ibid. Op. cit., p. 135, pl. 17, f. 18 and 19.
1850. „ *maculata,* Diesing. Syst. Helm., vol. i, p. 247.
„ „ *tubicola,* Ibid. Op. cit., p. 247.
„ *Tetrastemma fuscum* (partim), Ibid. Op. cit., p. 257.
„ „ *varicolor* (partim), Ibid. Op. cit., p. 257.
1853. *Vermiculus variegatus,* Dalyell. Pow. Creat., vol. ii, p. 91, pl. 10, f. 25 and 26.
1859. *Tetrastemma variegatum,* Leuckart. Archiv für Naturges., ii, p. 188.
1862. *Œrstedia maculata,* Diesing. Revis. der Turbell., p. 263.
„ „ *tubicola,* Ibid. Op. cit., p. 263.
„ *Tetrastemma fuscum,* Ibid. Op. cit., p. 289.
1863. „ *variegatum,* Ibid. Nachträge zur Revis. der Turbell., p. 10.
„ „ *marmoratum,* Claparède, Beobach. über Anat. u. Entwicklung., &c., p. 24, taf. 5, f. 14.
1865. „ *variegatum,* Johnston. Catalogue Brit. Mus., pp. 20 and 289.
1866. „ „ Lankester. Ann. Nat. Hist., 3rd Ser., vol. 17, p. 388.
1868. „ „ McIntosh. Rept. Brit. Assoc., 1868, p. 340.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 339 et seq.

Habitat.—Abundant in the laminarian region, in three to ten fathoms, where it haunts *Ceramium rubrum* and other algæ. It is also occasionally found under stones at extreme low water. Extends from Shetland to the Channel Islands.

Body half to three quarters of an inch in length, and rather more than half a line in breadth. It is so round as to be nearly circular in transverse section, with the exception of a little flattening on the ventral surface ; very slightly tapered at either extremity.

Colour.—On the coasts of Scotland two varieties are especially common. The most abundant form is of various shades of brown or reddish-brown, speckled with groups of yellowish-white granules, often of considerable size, which are placed along the centre of the dorsum from one end of the body to the other, but they do not form a continuous stripe. In some there is also a distinct brown lateral line. The other variety is reddish-brown, with a pale yellow dorsal stripe from snout to tail. The sepia-brown grains of the dorsum are placed on a reddish-brown ground. As soon as the pigment of the body becomes dark enough, a fine purplish lustre is produced by the play of light on the cilia, and the animal assumes a rich velvety aspect. In these dark examples, with a reddish-yellow central stripe, the under surface of the snout generally presents two pale symmetrical ovoid spaces a little behind the line indicating the mouth. In some cases the yellowish grains are scattered over both dorsal and ventral surfaces, and are quite characteristic of the species. In a large example dredged in Bressay Sound the dorsum was curiously variegated with patches of cinnamon-brown on a general ground-colour of pale brown speckled with yellowish grains, the pale brown of the ventral surface having a few specks of the same hue as the dorsum. The ventral surface is somewhat pale in all cases, and occasionally assumes a dull brownish-orange posteriorly. When floating with the ventral surface uppermost, a brownish margin is generally visible. Young examples are occasionally reddish-orange.

Head somewhat truncate and even notched in front, slightly narrowed posteriorly towards the cephalic furrows, and very little flattened. Eyes four, nearly in a square, the first pair being further from the tip of the snout than the last are from the cephalic furrows. They are deeply situated, and somewhat lateral in position—from the roundness of the snout when seen from above, and in profile appear considerably below the dorsal line. A variety from the harbour of Symbister, in Whalsay (Shetland), has the head somewhat pointed and better defined than usual, and the tail is also more tapered.

Cephalic furrows.—The anterior furrows are not visible on the dorsum. The posterior slant inwards and slightly backwards some distance behind the posterior eyes, meeting in the middle line. On the ventral surface they are directed slightly forward.

T. dorsalis is a marine rather than a littoral form, and sometimes occurs in vast numbers clinging to the débris of various seaweeds dredged in the laminarian region. It is hardy in confinement, either gliding with scarcely an undulation of its body, or rolling its snout from side to side in a peculiar manner as it progresses along the glass. It is also fond of enclosing itself in a tough transparent sheath, which is fixed to the wall of the vessel at the water-line. The sheath is highly elastic, and, while remaining perfectly transparent under a high power, is yet minutely streaked with translucent granules or specks, which are not due to fine creases or folds. The animal often reverses itself in the tube, and is sometimes doubled therein. It is curious to watch the pertinacity with which it progresses in a definite direction to stretch itself along the water-line.

The ova are deposited in the beginning of September, but some latitude is necessary in this respect, since specimens from deep water produced ova in June.

This species was brought into notice by P. C. Abildgaard in the fourth volume of O. F. Müller's celebrated 'Zoologica Danica;' and though he did not observe the eyes, his account is otherwise good. He terms it an eyeless brown 'Planaria,' with a pale ventral surface and a white dorsal line, and which constantly twists itself and loves to swim on its back. M. de Quatrefages, again, made a distinction between two varieties of this species, one of which (*Œrstedia tubicola*), he said, formed a tube, while the other (*O. maculata*) did not. Moreover, he elevated them into a new genus—characterized by the sublateral position of the nerve-trunks, and their cylindrical bodies. Their structure, however, is in all respects strictly conformable to the type of the Enopla. The large size of *O. maculata* (3 to $3\frac{1}{2}$ in.) from the shores of Sicily is peculiar. Sir J. Dalyell says it is rare, and that its colour is universally variegated red and white, with a white line down the back, but his drawing shows only interrupted specks along the dorsum. This excellent author held the opinion, which I cannot endorse, that the *Planaria dorsalis* of Abildgaard referred to a fragment of *Lineus bilineatus*. The *Tetrastemma marmoratum* of M. Claparède, from the coast of Normandy, is the present species. The cylindrical form of the body had previously been known.

Genus III.—Prosorhochmus,[1] *Keferstein*, 1863.

The typical species of this genus was first mentioned by Col. Montagu (MS., Library of the Linnean Society), who, however, was inclined to refer it to the *Planaria candida* of O. F. Müller. It is unlikely that so common a species escaped the notice of observers from the foregoing period up to 1863, the date at which Professor Keferstein published his descriptive characters of the genus in his 'Untersuchungen,' but it is probable that it was confounded with other forms. The four eyes which are characteristic of the previous genus are retained, only they do not form a rectangle. I would not place much weight (generically) on the ovo-viviparous character, as this is a condition which further investigation will probably extend to many genera.

Generic character.—Eyes four, not forming a rectangle; snout dimpled and furnished with a transverse superior lobe. Ovo-viviparous.

Prosorhochmus Claparedii, *Keferstein*. Plate II, fig. 4.

Specific character.—Snout blunt; eyes placed far back, the space between the anterior pair widest; yellowish. Other characters as in the genus.

Synonyms.

1808. *Planaria flava*, Montagu. MS., p. 237, tab. 35, f. 2.
1846. *Polia fumosa*, De Quatrefages. Annal. des sc. nat., 3me sér., Zool., vi, pp. 206-7. ?
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 118, pl. 14, f. 9—11. ?
1862. *Prosorhochmus Claparedii*, Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 61, taf. 6, f. 1—5.
1863. „ „ Diesing. Nachträge zur Revis. der Turbell., p. 10.
„ „ „ Claparède, Beobach. über Anat. u. Entwick., p. 23, taf. 5, f. 10—12.
1869. „ „ McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 344 et seq.

Habitat.—Under stones, and in fissures of rocks between tide-marks, on the southern shores of England, and in the Channel Islands.

Body an inch to an inch and a half in length, and three quarters of a line in breadth, flattened, somewhat narrowed behind the head, then gradually dilating, continuing for some distance of nearly equal diameter, and again diminishing towards the tail. In those examples in which the ovisacs are filled with developing young the body is round. The anus is very distinct.

[1] πρόσω, the front, and ῥωχμός, a fissure.

Colour pale yellow, or, in some, pale orange, with two translucent spots behind the eyes, marking the situation of the ganglia. Long confinement increases the number of the dull orange grains on the dorsum. The young have numerous orange pigment-specks in their skins at birth.

Head wider than the succeeding portion of the body, though not distinctly defined posteriorly, broadly spathulate as well as somewhat truncate in front, and with a well-marked central notch from which a pale streak proceeds some distance behind the ganglia. Just behind the notch is a transverse furrow, furnished with very long cilia, which have a radiate appearance under the microscope. Eyes situated considerably behind the tip of the snout, the anterior pair being the larger, and while those of opposite sides are widely apart, those on the same side are closely approximated. The anterior pair under pressure often present a crescentic margin in front, and I have seen a clear globule in connection with them, which may represent a lens. In profile the two halves of the snout in front form a pair of large and prominent lips, with the mouth underneath and behind—in the shape of a well-marked elliptical or ovoid slit, while a third lobe, less prominent, occurs on the dorsum. The trilobed condition of the snout is well seen in small specimens placed between glasses separated by a chip.

Cephalic furrows.—A very slight notch is observed opposite the first pair of eyes, which indicates the opening of the cephalic pit, and an indistinct furrow runs from this point inwards.

P. Claparedii is not so active and restless in its movements as some of its allies, but it is the most hardy four-eyed example of the Enopla I have yet seen, even more so than *T. dorsalis.* The specimens bore a journey from the Channel Islands to Scotland without the loss of one, or rather with a considerable increase, since the adults gave birth to numerous young individuals. It is interesting to see the comparatively large embryo moving in the interior of the adult, without interfering with its comfort in any way. They are observed in the bodies of their parents in July, and some remained there till October, having meantime considerably increased in size. Under pressure the embryos sometimes escape *per anum.* Both young and old are fond of leaving the water and remaining on the side of the vessel in the open air, and dozens of the former are frequently found floating on the thin whitish film which gathers on the surface of the sea-water after long keeping. They appear to be somewhat social animals in the free condition, as groups of adults (from ten to fifteen in number) are occasionally found in fissures of the rocks at St. Peter Port, Guernsey.

If the indefatigable Col. Montagu had published his notes and figure of this species it now would have borne his name. He describes it as "long, filiform, yellow, with the front rounded and slightly bifid. Four eyes placed quadrangular." Five were found entwined together on the coast of Devon. He thought it might be the *Planaria candida* of Müller, but the arrangement of the eyes and other points in his figure, together with the description, show its real nature. Œrsted remarks that the anterior pair of eyes in his *Tetrastemma subpellucidum* are widest apart, but we are otherwise left in doubt as to the actual species he describes. The *Polia fumosa* of M. de Quatrefages has certain close resemblances to this form, such as the arrangement of the eyes and the truncated snout, and it is difficult to see to what species the author refers if not to this. The colouring of the figure (op. cit., fig. ix, A, B) is much too dark, and the outline not at all characteristic. The enlarged anterior end, however, in fig. X, though not accurate, can scarcely apply to any other species. He found it in fissures of the rocks at St. Vaast and Bréhat. It was not till more than half a century after the English naturalist's observations that Prof. Keferstein published his account of the animal from specimens collected at St. Vaast-la-Hougue. His statement, however, that its mouth is behind the ganglia is erroneous, and it may be remarked that the position of the mouth is more easily seen in this species than usual. The occurrence of three marginal stylet-sacs in some examples is evidently accidental or abnormal.

The notched condition of the anterior border of the snout, so characteristic of this species, is very conspicuous in a large and flattened member of the Enopla, from New Zealand, in the British Museum. The specimens (in spirit) are about three inches long.

Sub-Family—Nemertinæ.

Proboscis proportionally small.

Genus IV.—Nemertes, *Cuvier*, 1817 (Char. emend.).

Cuvier founded this genus for the description of *Lineus marinus*, which previously had received other names, and therefore the new title ought to have lapsed. But being set abroad by a zoologist so distinguished, it naturally came to be much employed in describing numerous and often diverse genera, as well as used by subsequent authors as the title of the entire order. Though the genus was first established, therefore, for the reception of one of the Anopla, yet the name has very frequently been bestowed on forms belonging to the Enopla, and, besides, claims attention from its priority, both as a generic title and as applied to one of the typical forms (*Nemertes gracilis*) of this genus.

Generic character. — Body more or less elongated, while the proboscis is very much diminished, the anterior region of the organ especially being shortened, so as to cause the central stylet to approach the ganglia.

1. Nemertes gracilis, *Johnston.* Plate II, fig. 5.

Specific character.—Eyes numerous; snout broader than the rest of the body; central stylet of proboscis with an extremely long basal apparatus. Greenish or olive.

Synonyms.

1837. *Nemertes gracilis,* Johnston. Mag. Zool. and Bot., vol. i, p. 534, pl. 17, f. 1.
1841. „ „ W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.
1844. *Polystemma gracile,* Œrsted. Entw. Plattw., p. 93.
1846. *Prostoma gracilis,* Johnston. Ann. Nat. Hist., vol. xvi, p. 435.
„ *Nemertes balmea,* De Quatrefages. Ann. des sc. nat., 3^{me} sér., Zool., tom. vi, p. 197; tab. 9, f. 3—6; tab. 11, f. 2, and 4; and tab. 12, f. 2.
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 109, pl. 10, f. 6 and 7, and pl. 19, f. 3—6.

1850. *Omatoplea balmea,* Diesing. Syst. Helm., vol. i, p. 249.
„ „ *gracilis,* Ibid. Op. cit., p. 250.
1862. „ *balmea,* Ibid. Revision der Turbell., p. 255.
„ „ *gracilis,* Ibid. Op. cit., p. 255.
1865. „ „ Johnston. Catalogue Brit. Mus., p. 22, pl. ii *a*, f. 1 and 1*.
1869. „ „ McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 334 et seq.

Habitat.—Frequent under stones between tide-marks, and especially abounding under tangle-roots at low water. No example, however, was met with during an excursion to the Channel Islands.

Body.—Eight to twenty inches in length, and about a line in breadth, flattened in progression, and thrown into ever-varying wrinkles, dilatations and contractions. The diameter is nearly uniform for a considerable distance behind the head, and then the body gradually tapers towards the tail. It is occasionally attenuated to a mere thread.

Colour.—Dull greyish-green on the dorsum, deepest in front, and somewhat duskier in the centre from the hue of the alimentary tract. Some incline to bluish-green anteriorly, others are dull olive throughout. There are two reddish specks (due to the ganglia) behind the head. In some specimens the dorsum for a short distance posterior to the latter is marked with minute pale specks or with black pigment-grains, the latter occasionally continuing to the tip of the tail. The under surface is greyish-white, dappled in the ripe females with dull whitish spots from the ova. The reddish colorations from the ganglia are best observed on this surface, and there is also a pale streak in the œsophageal region.

Head.—Somewhat spathulate, flattened, rather blunt at the tip, and slightly dilated laterally, so as to be wider than the rest of the body. Eyes arranged in two or three groups on each side, the anterior cluster containing the larger number, and being situated just within the pale border of the snout. The number of eyes in this series ranges from five to nine, but, as usual, it is variable. The next group is placed distinctly posterior, nearer the middle line of the head, and consists of three, four, or five eyes, which in some are transversely arranged. The third cluster lies at the anterior border of the ganglion, or, occasionally, proceeds backwards along the outer border of the latter. The first-mentioned groups are visible from the ventral surface.

Cephalic furrows.—There are no evident furrows on the dorsum of the head, and inferiorly there is only the central slit of the mouth.

This species lives a considerable time in confinement. Sometimes, when it has stretched its snout beyond the water-line, while its tail reaches the bottom of the vessel, it assumes a very regular spiral arrangement. If the snout be loosened from its attachment, the body is at once gracefully shortened, like the stalk of a Vorticella or a coiled spring. It can also attenuate itself to an extreme degree. It secretes a very tenacious, transparent mucus, especially when irritated, and envelopes itself therewith, apparently for protection. The fine threads of this secretion are so tough that they support the animal when lifted above the surface of the water. The skin is acid to test-paper.

Nemertes gracilis spawns in May.

This animal was discovered by Dr. Johnston on the coast near Berwick, a region that became so rich in novelties under his patient and searching scrutiny. It was re-described many years later by M. de Quatrefages under the name *Nemertes balmea,* from Bréhat. The French author did not observe any cephalic furrows, or "genital aperture" (mouth), and therefore he concluded that the latter was a temporary orifice. Its mouth occupies the usual position.

2. Nemertes Neesii, *Œrsted.* Plate III, fig. 6; and var., Plate VII, fig. 6.

Specific character.—Eyes numerous. Stylets short and grooved. Streaked with purplish-brown on the dorsum.

Synonyms.

1828. *Planaria flaccida,* Johnston. Zool. Journ., vol. iii, p. 488.
1844. *Amphiporus Neesii,* Œrsted. Kroyer's Naturhist. Tids., iv, p. 581.
„ „ „ Ibid. Entw. Plattw., p. 95.
1846. *Borlasia? flaccida,* Johnston. Ann. Nat. Hist., vol. xvi, p. 435.
„ „ *camillea,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 194, tab. 9, f. 1, and tab. 14, f. 3.
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 106, pl. 10, f. 4 and 5.
„ *Amphiporus Neesii,* Leuckart. Archiv für Naturges., i, p. 149.
1850. „ „ Diesing. Syst. Helm., vol. i, p. 245.
„ *Nemertes camillea,* Ibid. Op. cit., p. 274.
1853. *Gordius fuscus,* Dalyell. Pow. Creat., vol. ii, p. 83, pl. 9, f. 15 to 17, and pl. 12.
1859. *Amphiporus Neesii,* Leuckart. Archiv für Naturges., ii, p. 187.
1862. *Borlasia Neesii,* Diesing. Revis. der Turbell., p. 249.
„ *Emplectonema camillea,* Ibid. Op. cit., p. 306.
1865. *Serpentaria fusca,* Johnston. Catalogue Brit. Mus., pp. 28 and 298.
1865-6. *Borlasia camillæ,* De Quatrefages. Hist. Nat. des Annelés, pl. 4, f. 14.
1866. *Serpentaria fusca,* Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.
1868. *Ommatoplea purpurea,* McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
„ „ „ Ibid. Report Brit. Assoc., 1868, p. 340.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, p. 336 et seq.

Habitat.—Under stones between tide-marks, in crevices of rocks and tangle-roots near low water, and in fissures of the Gouliot caves, Sark. It also occurs on the tangle-ground in Shetland, and in deep water off the east coast of Scotland. Ranges from Iceland to the Channel Islands.

Body.—Four to eighteen inches in length, and, in large specimens, about a quarter of an inch in breadth, elongated, much flattened, appearing almost of equal diameter throughout, though in reality slightly tapering towards the posterior end. It is generally thrown into numerous equidistant transverse wrinkles, which are only obliterated in extreme extension.

Colour.—Variously speckled madder-brown, with a faint purplish iridescence from the play of light on the cilia. Towards the anterior part of the body the specks are more marked, and the general colour somewhat paler, especially on the head. Behind the latter the dorsum assumes a streaky appearance, brown being the predominant hue, with longitudinal flesh-coloured stripes, all of an interrupted character. The lateral regions abound with brown specks. Towards the tail the colour again becomes paler, and the dorsal specks more numerous. The entire under surface is pale pinkish-white, or skin-coloured. In the darker specimens the streaks are less numerous, though more boldly marked. Some examples are of a very pale brownish hue, the dorsum having only pale brown pigment-grains and no streaks. Other varieties, again, are very curiously mottled, like polished rosewood or walnut, or of a faint yellow, speckled with brown. Young specimens from deep water are occasionally almost white, or faint skin-colour, and some have a uniform dull orange hue, from the digestive chamber. The proboscis in the latter examples is pale pink. Young specimens, and those from dark recesses, are generally pale.

Head.—Spathulate, wider than the rest of the body, with a pale margin, and a central streak from the notch or dimple in front backwards. Eyes numerous, arranged in two dense clusters on each side—a little behind the tip of the snout. Unless in pale specimens, they are distinguished with difficulty on account of the dark coloration of the dorsum. They are larger than the eye-specks of *N. gracilis.*

Cephalic furrows.—The snout is bounded posteriorly by two dorsal transverse grooves, which also mark a slight constriction. On the under surface two furrows slant outwards and backwards from the mouth, a short distance behind the tip of the snout, and from these the openings of the cephalic pits proceed. They are visible as two curved lines, which do not reach the lateral margin of the body, and thus are wholly ventral.

N. Neesii is rather plentifully distributed on our coasts, four or five being occasionally procured under one stone, or in a fissure of the shelving rocks. The facility with which it coils and twists its body in all directions is most interesting. Sometimes the posterior part of the animal lies in a tangled knot, while the anterior extends outwards as a long screw, the alternate dark and light shades of the dorsal and ventral surfaces forming a very agreeable contrast; and from the frequency with which it assumes this attractive position one might be excused in attributing to the animal some sense of the splendour with which nature has endowed it. It floats with ease on the surface of the water, the body being thrown into various undulations, as when progressing on the surface of the ground, though, of course, more slowly and less distinctly. It is killed by immersion in fresh water, the body before death being surrounded by a tough coating of mucus, like many of its allies and the Dorides. The skin is alkaline to test-paper.

In one specimen of a pale brick-red hue, from Guernsey, the muscular investment of the basal apparatus of the central stylet was abnormal (a state that could scarcely have resulted from degeneration, for it was examined on the third day after capture), being elongated posteriorly and split into processes like rootlets, from the peculiarities of the fibres.

It spawns in March and April.

The *Lineus maculosus* of Montagu (MS., p. 274) can scarcely refer to any other British form than the above. It is described as "rufous-brown, mottled, beneath white, resembling *L. marinus.* Length more than a foot, and not larger than *Gordius aquaticus.*" Dr. Johnston, however, first published an account of the species, from a specimen coiled in a valve of *Saxicava rugosa,* from deep water in Berwick Bay. The *Amphiporus Neesii* of Œrsted, as R. Leuckart mentions, is clearly synonymous with the *Gordius fuscus* of Dalyell (the present species), and as Œrsted's specific title is free from the objections connected with Johnston's, it has been chosen. Sir J. Dalyell noticed its tendency to coil in knots. His examples spawned in April, the ova merely lying in a "thin albuminous matter" (probably mucus), and covering the bottom of a vessel two inches in diameter. He hazarded the opinion that the mouth was apparently in the anterior part. There is nothing to indicate specific distinction from the present form in the description and figures of the *Borlasia camillea* of De Quatrefages. I cannot, however, make the same statement with regard to the *Emplectonema camillea* of Stimpson and the *Nemertes camillea* of Williams. Two specimens in the British Museum, from Greenland, have very short, thick bodies, and the proboscis in each is proportionally large; but these appearances may be due in some respects to the mode of preparation.

This species has sometimes been confounded with "Serpentaria fragilis" (*Cerebratulus angulatus*).

3. Nemertes carcinophila, *Kölliker*. Plate I, fig. 5.

Specific character.—Eyes two; proboscis furnished with a central stylet only. Body of a pale pink colour.

Synonyms.

1845. *Nemertes carcinophilos*, Kölliker. Verhandl. d. Schweiz. naturf. Gesellsch. in Chur., p 89.
1850. „ „ Von Siebold. Archiv für Naturges., p. 382.
1860. *Polia involuta*, Van Beneden. Recher. sur les Turbell. (sep. copy, from Mém. Acad. Belg., tom. xxxii), p. 18, pl. 3.
1862. *Cephalothrix involuta*, Diesing. Revis. der Turbell., p. 254.
„ *Nemertes carcinophila*, Ibid. Op. cit., p. 298.
1869. *Polia involuta* (*Nemertes carcinophila*, Kölliker), McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 309 et seq.

Habitat.—Abounds in tubes attached to the abdominal hairs of female specimens of *Carcinus mœnas* bearing ova. Messina and the Coast of Belgium.

Body.—One to two inches long, scarcely so thick as a thread during extension, flattened, nearly equal in diameter throughout, or very slightly tapered at head and tail.

Colour.—Pale skin or slightly pinkish; pale rose-pink in contraction or when coiled *en masse*. There is a pale patch behind the snout, indicating the region of the proboscis.

Head.—Slightly tapered towards the anterior end, not defined from the rest of the body, and ending in a blunt snout. Eyes two, situated considerably behind the tip of the latter.

It is a somewhat sluggish animal, lying doubled in its sheath, or when removed gliding about the vessel in a slow, feeble manner. It is also less hardy in confinement than the majority of the group.

N. carcinophila spawns in April, and it is easy to watch the development of the young.

Prof. Kölliker first found the worm in its usual position on a small crab at Messina, and his account of it is quite characteristic. This paper, however, escaped the notice of M. van Beneden, who re-described it as a new species from "*Cancer mœnas*" many years subsequently. It is not strictly a parasite of the shore-crab, but, like diverse annelids in other sites, it seems to find the hairs of the abdominal feet of females bearing ova a convenient position for its sheaths, and probably for protection and a proper supply of food. In the same way the *Tetrastemma* before mentioned frequents the branchial chambers of the Ascidians, the *Planaria angulata* of Agassiz (not Müller) the under surface of *Limulus*, and the *Planariæ* the cavities of the Medusæ; or, as *Harmothoë imbricata*, *Polynoë areolata*, and others, live in harmony with *Chœtopterus norvegicus* in its tube, and *Polynoë scolopendrina* with *Marphysa sanguinea* and *Terebella nebulosa* in their tunnels.

Prof. van Beneden, however, correctly indicates its affinity with the *Prorhynchus stagnalis* of Max Schultze, a freshwater species, and gives an interesting if not strictly accurate account of its development.

Sub-Order—ANOPLA.

Proboscis without stylets.

Family II.—Lineidæ.

Genus V.—Lineus,[1] *Sowerby*, 1806.

The typical species of this genus was one of the first Nemerteans known to science, viz. the *Gordius marinus* of Montagu. The generic name employed by the latter, however, as he himself was well aware, could not stand; and while he was waiting till the discovery of other species would enable him to give a more comprehensive description of the genus, Sowerby published 'The British Miscellany,' in which the generic name above mentioned was bestowed on the same characteristic species.

Generic character.—Body more or less elongated, rounded or somewhat flattened, and tapered posteriorly. Head distinct, spathulate, and generally truncate in front. Eyes numerous, arranged along the sides of the snout anteriorly; rarely absent. Mouth in the form of a conspicuous longitudinal slit on the ventral surface. Other characters as in the family.

1. Lineus marinus, *Montagu*. Plate IX; and Plate XVIII, figs. 1—3.

Specific character.—Eyes numerous, deeply set in a marginal row on each side of the snout. Of a blackish or very dark olive colour, more or less distinctly streaked longitudinally. Body rather rounded.

Synonyms.

1758. *Sea-Long Worm*, Borlase. Nat. Hist. Cornwall, p. 255, tab. 26, f. 13.
1804. *Gordius marinus*, Montagu. Linn. Trans., vol. vii, p. 72.
1806. *Lineus longissimus*, T. W. Simmons. Sowerby's Brit. Misc., p. 15, pl. 8.

[1] *Linea*, a line.

1807. *Lineus longissimus*, Turton's British Fauna, p. 130.
1808. „ *marinus*, Montagu. MS., p. 271.
1811. „ *longissimus*, Jameson. Wernerian Memoirs, vol. i, p. 557.
1812. *Gordius marinus*. Pennant's British Zoology, vol. iv, p. 74.
1815. *Borlasia angliæ*, Oken. Lehrbuch, &c., p. 365, tab. xi, f. 4.
„ *Gordius marinus*, Davies. Trans. Linn. Soc., vol. xi, p. 292.
1816. „ „ Ibid. Lond. Med. and Phys. Jour., xxxvi, pp. 207-9.
1817. „ „ Ibid. Extr. in Isis, 1817, pp. 1054-56.
„ *Nemertes Borlasii*, Cuvier. Règ. An., tome iv, p. 37.
1828. *Borlasia angliæ*, De Blainville. Dict. des sc. nat., 57, p. 575; ibid., Atlas, Parentomozoaires, f. 1 *a*—1 *d*.
1834. *Nemertes Borlasii*. Griffith's Cuv., vol. xii, p. 468.
1836. *Borlasia longissimus*, Templeton. Loud. Mag. Nat. Hist., vol. ix, p. 236.
1838. *Nemertes Borlasii*, W. Thompson. Charlesworth's Mag. Nat. Hist., vol. ii, p. 21.
1843. *Borlasia striata*, Rathke. Beitr. z. Fauna Norweg. (Nov. Act. Nat. Curios., xx), p. 231.
1842-3. „ *angliæ*, Œrsted. Kroyer's Naturhist. Tids., iv, p. 572, in nota.
1844. *Nemertes Borlasii*, Ibid. Entw. Plattw., p. 92.
„ „ *striata* (Rathke), Ibid. Op. cit., p. 92.
1845. „ *gracilis*, H. Goodsir. Ann. Nat. Hist., vol. xv, p. 378, pl. 20, f. 3.
1845.? „ *Borlasii*, De Quatref. Règne An. illust. (Zoophytes, 12e livraison, pl. 83).
1846. *Lineus longissimus*, Johnston. Ann. Nat. Hist., vol. xvi, p. 435.
„ „ *gracilis*, Ibid. Op. cit., p. 435.
„ *Borlasia angliæ*, De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 192, tab. 8, f. 4 and 5; tab. 10, f. 8; tab. 12, f. 3 and 4; and tab. 13, f. 1—3 and 5—9.
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 104, pl. 9, f. 7; pl. 11; and pl. 12, f. 2, &c.
1850. *Meckelia Borlasii*, Diesing. System. Helm., vol. i, p. 265.
„ „ *gracilis*, Ibid. Op. cit., p. 268.
„ *Nemertes striata*, Ibid. Op. cit., p. 274.
1851. *Lineus longissimus*, Williams. Rept. Brit. Assoc., 1851, p. 244, f. 64 (?)
1853. *Gordius maximus*, Dalyell. Pow. Creat., vol. ii, p. 63, pl. 8, and pl. 9, f. 1.
1855. "An ascaroid or planarian worm." North Brit. Review, No. 43, p. 38.
1856. *Borlasia nigra*, Byerley. Fauna of Liverpool, p. 98.
1857. *Nemertes Borlasii*, De Quatrefages. Ramb. of a Naturalist, Eng. edit., vol. i, p. 116.
1859. „ „ Kingsley. Glaucus, p. 124, pl. 3, f. 1.
„ *Borlasia angliæ*, Leuckart. Archiv für Naturges., ii, p. 187.
1860. *Nemertes Quatrefagii*, Van Beneden. Recher. sur les Turb., &c., p. 15, pl. 2, f. 5—9, var.
1862. *Meckelia Borlasii*, Diesing. Revis. der Turbell., p. 285.
„ „ *gracilis*, Ibid. Op. cit., p. 303.
„ „ *Quatrefagii*, Ibid. Op. cit., p. 304.
1863. „ *Borlasii*, Diesing. Nachträge z. Revis. der Turbell., p. 8.
1865. *Borlasia striata*, Johnston. Catalogue Brit. Mus., pp. 22 and 291.
„ „ *longissimus*, Ibid. Op. cit., pp. 25 and 293.
„ „ *gracilis*, Ibid. Op. cit., pp. 26 and 295.
„ „ *lineatus*, Ibid. Op. cit., pp. 26 and 295.
„ „ *murenoides*, Ibid. Op. cit., p. 26.
„ „ *fasciatus*, Ibid. Op. cit., pp. 26 and 295.
1866. „ *longissimus*, Lankester. Ann. Nat. Hist., 3d ser., vol. xvii, p. 389.

1866. *Borlasia gracilis,* Ibid. Op. cit., p. 389.
„ „ *lineatus,* Ibid. Op. cit., p. 389.
1867. „ *longissimus,* Parfitt. Catal. Annel. Devon, p. 8.
„ „ *lineatus,* Ibid. Op. cit., p. 8.
1868. „ *longissimus,* McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
„ „ „ Ibid. Proceed. Linn. Soc., vol. x, p. 251.
„ „ „ Ibid. Rept. Brit. Assoc., 1868, p. 340.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374 et seq.

Habitat.—Not uncommon under stones between tide-marks, either in or out of tidal pools, in fissures of rocks, amidst tangle-roots in the laminarian zone, and occasionally in deep water.

Body.—Fifteen to thirty feet to as many yards in length, and from one to four lines in breadth, rather rounded, slightly narrowed behind the head, continuing of nearly equal calibre throughout the greater part, and then gradually narrowing towards the tail.

Colour.—Blackish-brown, relieved throughout by the fine purplish iridescence of the cilia. The tip of the snout is pale or whitish, and there are three pale bands from this region backwards. The central passes along the body a considerable distance, but gradually becomes indistinct, and the two lateral, which follow a similar course on the dorsum, vanish sooner. In addition to the foregoing, a very distinct pale stripe commences on each side at the posterior part of the cephalic fissure, and courses along the infero-lateral region of the body to the tip of the tail. Another well-marked stripe commences on the ventral surface at the centre of the snout, and continues along the middle nearly to the termination of the body. There is not much difference in colour between the dorsal and ventral surfaces. In young examples the brown is much paler, assuming an olive-brown or olive hue, and the stripes are more numerous and conspicuous; indeed, there is considerable variety in this respect. Generally, a reddish coloration is observed on both surfaces in the ganglionic region. The stripes exist on many good spirit-preparations, those on the head being especially distinct, and the slight eversion of the mouth causes a pale margin (or lip) all round. In dark specimens the lateral lines of the body are the most conspicuous. The rich dark colour of many shows that they are not unused to light in their native haunts.

Head.—Wider than the succeeding portion of the body, narrowed towards the anterior and posterior borders. The tip of the snout is generally bilobed, with a distinct papilla in the centre and two small ones on each lateral eminence. On each side is a deep lateral fissure with large lips, the superior being often rolled or curved inwards. The fissures have the usual reddish hue posteriorly. There is a dense group of eyes on each side of the anterior margin of the snout, arranged in a longitudinal manner, or rather their outline forms a long wedge—narrow anteriorly and wide posteriorly. In very dark examples these eyes are not easily seen, indeed they have escaped the notice of many observers; but if the animals are kept in confinement a long time, the bleaching of the snout renders them conspicuous, as may be noticed by contrasting the large coloured figure in Plate IX with Plate XVIII, fig. 1, which (latter) represents the head of the same specimen upwards of a year after its capture. In young animals the eyes are easily seen from the dorsum.

This is unquestionably the giant of the race, and even now I am not quite satisfied about the limit of its growth, for after a severe storm in the spring of 1864 a specimen was thrown on shore at St. Andrews which half filled a dissecting jar eight inches wide and five inches deep. Thirty yards were measured without rupture, and yet the mass was not half uncoiled. It chiefly delights to lurk under stones not far from low-water mark, or in tidal pools, and is occasionally found looped like a living string of caoutchouc amongst the seaweeds fringing the sides of the latter. It is useless in such a case to attempt to capture the worm by pulling at the free end, for, although it resists considerable tension, rupture is apt to follow: it should be allowed to contract itself, and then lifted or rolled in a mass into the vessel. At first sight it seems strange that nature should have fashioned an animal so soft and apparently so helpless as this, devoid of arms either of offence or defence throughout its extreme length, and which, moreover, can be so easily ruptured. Yet the facility with which reproduction can take place in wounded examples on the one hand, and the shelter afforded by its site on the other, give it sufficient protection in the struggle for existence as an adult form, while the enormous powers of increase in the ordinary way by ova render the continuance of the species doubly secure.

There is something remarkable in the movements of a large specimen of this huge worm, as its quivering body emerges from a dark creek in one of the little caverns that abound amongst the tidal rocks. No useless bustle warns its companions of its approach, but it glides silently forward with its exploratory snout, and scatters the smaller inhabitants by the very stealth and suddenness of its appearance. Some may even be excused in reckoning it the evil genius of the pool—dark, slimy and mysterious, moving hither and thither, as it were, by an invisible agency, and whose ways, like the inextricable knots and coils of its serpentiform body, are difficult to find out. It is not to be more harshly judged, however, than the young *Cotti*, Shannies, and *Cyclopteri*, that shelter themselves from its approach amidst the blades of the trailing tangles, the *Hippolytes* and *Mysidæ* that reconnoitre it from under the fringes of Corallina, Ulva and Cramium, the *Idoteidæ* and *Caprellidæ* that climb monkey-like on their branches, or than the sluggish *Doris* adherent to the variously tinted *Halichondria*. All are equally predatory, and subserve the special ends for which they live; and if the elongated worm preys by stealth and not by swift and open attack, this is due to its physical constitution, and not to any acquired vice or degradation. If it swallows its prey alive, it is, at any rate, devoid of instruments of laceration or torture, such as the jaws of its higher allies or the thread-cells of the Hydrozoa.

L. marinus lives well in confinement, and, without receiving any food, will survive for years, though the body greatly diminishes in size, both as regards length and thickness. Indeed, as in other examples, the insensible consumption of the formed tissues supports the animal under circumstances so abnormal, for we cannot place any weight upon food derived from microscopic organisms in so limited a supply of salt water, and one so rarely or never changed. Sickly specimens die from behind forward piece by piece, a fresh portion being thrown off at intervals until the head is reached. It is fond of taking refuge in tubes; thus a small one captured at Herm thrust out the rightful owner (a Protula), coiled itself therein, and is now preserved *in situ*. Several have also been found with the body looped through a broken *Trochus* or *Littorina*, which formed a kind of anchor in the runlets of sea-water in which their protecting stones lay. Not only do some fragmentary specimens, when put in spirit, turn themselves inside out, as Sir J. Dalyell saw in the living animal in salt water, but more than once I have been puzzled when making transverse sections by finding one part of the body doubled quite within the other, and this for a considerable distance. The entire skin gives a marked acid reaction to test-paper.

The breeding season would seem to be in June, but spermatozoa have been found fully developed in May and September. Sir J. Dalyell had a specimen which discharged innumerable white ova in May.

This Nemertean was first noticed by the Rev. W. Borlase, under the name of the Sea-Long Worm, but it received its scientific title from Col. Montagu. If subsequent writers on the Nemerteans had had the privilege of consulting the manuscript of this author, great confusion would have been avoided, and this not more conspicuously than in the present instance. He had observed the variable colours—from dusky to rufous-brown, and striped more or less plainly—of adults and young specimens. His description, on the whole, is excellent, though, in common with many other naturalists, he omitted to notice the eyes; and in his early account in the 'Linnean Transactions' it is probable he thought the proboscis the excreta. He makes the curious remark, that "It is not fragile unless contracted by spirits, for we have generally measured the length by winding upon a cylinder of wood of known circumference, suffering five or six feet of the animal to be pendent, in order to ascertain as nearly as possible the utmost length. In this state they have been suffered to die, and rarely break by contraction." Prof. Jameson observes that it was "noticed many years ago by my friend Mr. Neill, afterwards transmitted by the late Mr. Simonds to Mr. Sowerby, who has figured and described it . . . in his 'British Miscellany.'" He calls it the Black Worm of the Newhaven fishermen. The Rev. Hugh Davies did not see the eyes, and rather vaguely conjectured that it advanced by coiling its "amazing length into a compact spiral, each volution of which assisted in the act of progression," a supposition only less wide of the truth than that of M. de Quatrefages, who mentions that it glides through the water by means of excessively fine cilia. Sir J. Dalyell, again, considered that small examples floated less by their specific levity than by the repulsion of the lubricating matter investing the body, a method somewhat involved in obscurity. I am not satisfied that the *Ophiocephalus murenoides* of Delle Chiaje is this species; indeed, the flattened form and pointed snout shown in a figure in his 'Descrizione' point this out rather as allied to *Cerebratulus angulatus*, Müller, than to the present species. The so-called specimens of *Lineus murenoides*, also, of British naturalists, are all referable to *L. marinus*. I have included M. van Beneden's *Nemertes Quatrefagii* under the same head, for it seems to be only a pale and young variety, with the stripes distinctly marked. The arrangement of the eyes, as noted by this author in regard to his supposed new form, is equally characteristic of *L. marinus*.

2. Lineus gesserensis, *O. F. Müller*. Plate IV, fig. 2; and Plate V, fig. 1.

Specific character.—Eyes numerous, marginal. Snout distinctly wider than the rest of the body. Greenish, olive or reddish-brown.

Synonyms.

1766. *Alia* Lumbrici *marini* species, tota atra, Pallas. Miscell. Zool., p. 216, tab. 11, f. 9.
1771. Der Strömische Röd-Aat., O. F. Müller. Wurm-Arten des sussen u. salzigen W., p. 118, tab. iii, figs. 1—3.
1774. *Ascaris rubra*, O. F. Müller. Verm. terrest. et fluv. Hist., vol. i, ii, p. 36.
1776. „ „ Ibid. Zool. Danic. Prodr., p. 213, No. 2587.
1780. *Planaria fusca*, O. Fabricius. Fauna Grœnlandica, p. 324.

1788. *Planaria gesserensis,* O. F. Müller. Zool. Danic., ii, p. 32, tab. 64, f. 5—8.
„ „ „ Gmelin. Linn. Syst. Nat., tom. i, pars vi, p. 3093.
1798. „ *fuscescens,* O. Fabricius. Skriv. af Naturhist. Selsk., iv, ii, pp. 58—62, tab. 11, f. 8—10 (?)
1816. „ *gesserensis,* Lamarck. Hist. Nat. des an. sans vert., vol. iii, p. 179.
1827. „ „ Bosc. Hist. Nat. des vers, i, p. 262.
1829. „ *bioculata,* Johnston. Zool. Jour., vol. iv, p. 56.
1837. *Nemertes* (*Borlasia*) *olivacea,* Johnston. Mag. Zool. and Bot., vol. i, p. 536, pl. 18, f. 1.
„ „ *purpurea,* Ibid. Op. cit., p. 537, pl. 18, f. 3.
1843. *Borlasia rufa,* Rathke. Beiträge z. Fauna Norweg., p. 234 (?).
„ *Meckelia olivacea,* Ibid. Op. cit., p. 234.
1842-3. *Planaria gesserensis,* Œrsted. Kroyer's Naturhist. Tids., iv, p. 572, in nota.
„ *Nemertes olivacea,* Ibid. Op. cit., p. 578.
„ „ *purpurea,* Ibid. Op. cit., p. 579, in nota.
1844. *Tricelis gesserensis,* Œrsted. Entw. Plattw., p. 27.
„ *Nemertes olivacea,* Ibid. Op. cit., p. 89.
„ „ *fuscescens,* Ibid. Op. cit., p. 92.
„ „ *purpurea,* Ibid. Op. cit., p. 91.
1846. *Borlasia olivacea,* Johnston. Ann. Nat. Hist., vol. xvi, p. 434.
„ „ „ W. Thompson. Op. cit., vol. xviii, p. 388.
„ „ *purpurea,* Ibid. Op. cit., p. 388.
1847. „ *rufa,* Frey u. Leuckart. Beiträge z. Kennt. wirb. Thiere, p. 72, tab. 1, f. 15 and 16; var.
1849. *Nemertes fusca,* Leuckart. Archiv für Naturges., i, p. 152.
1850. *Notospermus gesserensis,* Diesing. Syst. Helm., vol. i, p. 260.
„ *Meckelia olivacea,* Ibid. Op. cit., p. 264.
„ „ *fusca,* Ibid. Op. cit., p. 266.
„ *Nemertes rufa,* Ibid. Op. cit., p. 271.
„ „ *olivacea,* Ibid. Op. cit., p. 273.
„ „ *purpurea,* Ibid. Op. cit., p. 275.
1852. „ *olivacea,* Max Schultze. Zeitsch. f. wiss. Zool., iv, p. 178.
1853. *Gordius minor viridis,* Dalyell. Pow. Creat., vol. ii, p. 72, pl. 9, f. 2—7.
„ „ *gesserensis,* Ibid. Op. cit., p. 73, pl. 10, f. 5.
„ *Vermiculus lineatus,* Ibid. Op. cit., p. 90, pl. 10, f. 19 and 20 (young with two eyes).
1857. *Cerebratulus oleaginus,* Stimpson. Proceed. Acad. Nat. Sc. Philad., p. 160.
„ *Nemertes olivacea,* Max Schultze. Icones Zootom. (V. Carus), tab. 8, f. 14.
1859. *Meckelia olivacea,* Leuckart. Archiv für Naturges., ii, p. 187.
„ *Gordius gesserensis,* Ibid. Op. cit., p. 187.
„ *Nemertes olivacea,* Ibid. Op. cit., p. 187.
1860. „ *flaccida,* Van Beneden. Recher. sur les Turb., &c., p. 14, pl. i, f. 14—17 (?)
1862. *Meckelia oleagina,* Diesing. Revis. der Turbell., p. 280.
„ „ *fusca,* Ibid. Op. cit., p. 285.
„ *Nemertes rufa,* Ibid. Op. cit., p. 298.
„ „ *gesserensis,* Ibid. Op. cit., p. 299.
„ „ *purpurea,* Ibid. Op. cit., p. 299.
„ „ *olivacea,* Ibid. Op. cit., p. 300.
„ „ „ Keferstein. Zeitsch. für wiss. Zool., Bd. xii, p. 66.
„ *Meckelia olivacea,* Diesing. Nachträge zur Revis. der Turbell., p. 8.
„ *Gordius gesserensis,* Ibid. Op. cit., p. 14.
„ *Nemertes olivacea,* Ibid. Op. cit., p. 14.

1865. *Borlasia olivacea,* Johnston. Catalogue Brit. Mus., pp. 21 and 289, pl. ii *b,* f. 1 and 1*.
,, ,, *gesserensis,* Ibid. Op. cit., pp. 21 and 290.
,, *Lineus viridis,* Ibid. Op. cit., pp. 27 and 296.
1866. *Borlasia olivacea,* Lankester. Ann. Nat. Hist., 3rd ser., vol. xviii, p. 388.
1867. ,, ,, McIntosh. Jour. Micros. Sc.; Trans., p. 39.
1868. ,, ,, Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. ,, ,, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 371 et seq.

Habitat.—Abundant on all our shores under stones between tide-marks, and in the laminarian region, from the Shetland to the Channel Islands.

Body.—Four to nine inches in length, breadth a line and a half or more, flattened, tapered towards the head, and more distinctly towards the tail; marked by numerous pale transverse wrinkles, somewhat regularly disposed, and most conspicuous in pale specimens.

Colour.—Two very distinct hues are characteristic of this species, viz. reddish-brown and dull olive, while pale reddish and green varieties are also occasionally met with. The pigment is generally darkest in front, before and behind the reddish mark in the ganglionic region, the rest of the body being uniformly tinted except towards the tail, which is paler. The snout is surrounded by a broad pale margin, as far back as the termination of the fissures. The ciliation gives the body under certain conditions either a purplish or an opalescent hue. The sides are often marked with numerous pale spots, from the generative apertures. The ventral surface is paler than the dorsal, especially towards the snout, which is also reddish posteriorly. The mouth is surrounded by a pale margin. Party-coloured varieties are sometimes found, the anterior region, for instance, being dark green mottled with white, while the posterior half is quite pale. Such bleaching is different from that caused by parasitic attacks.

Head.—Somewhat elongated, flattened, spathulate, rather truncate in front, with a small central and two lateral papillæ, and having on each side—from the tip of the snout backwards—a deep fissure with pale edges and a pinkish bottom, the latter hue being most distinct posteriorly. It tapers slightly anteriorly, and is decidedly wider than the succeeding portion of the body, on account of the lips of the lateral fissures. The eyes are situated at the anterior central pigmentary portion of the snout, and number from three to six or more on each side, the largest being generally in front. They are not always symmetrical; three, for example, occurring on one side, and occasionally eight on the other, besides some indistinct grains. The mouth opens as a longitudinal slit a short distance behind the ganglia.

L. gesserensis progresses in an easy, graceful manner, with slight undulatory motions of the head, its body being marked with successive contractile waves, which proceed from before backwards. The specimens frequently herd together in the water, which they are prone to leave, and remain attached to the side of the glass a considerable time. They are very easily kept in confinement for years; but, as with many of their allies, great diminution of bulk occurs, from deprivation of the natural supply of food. When recently captured specimens are placed in a jar containing injured Annelida, numerous fæcal masses, consisting of the bristles of *Nereis pelagica,* and other annelids and digested matter, are found lying on the bottom of the vessel, showing how greedily they have fed; a fact, indeed, very easily ascertained by actual observation. It is also frequently noticed that specimens confined in vessels along with the deep green *Eulalia viridis* assume a similar hue, probably from feeding on the rejected débris of those animals, if not upon the latter themselves. In their native haunts the stones under which they lie are often placed on dark, muddy and highly odoriferous sand or gravel, and the water cannot be otherwise than brackish at the estuary of a river.

The skin of this species gives an acid reaction.

The ova are deposited in gelatinous sheaths from January to May, and abound under stones in pools and moist places between tide-marks.

The want of precision in the descriptions of authors has burdened the literature of the present group of animals with diverse synonyms, especially as regards this widely distributed species. Though O. F. Müller's specific name *rubra* has the priority, and *fusca* comes next in order, yet, as each of these terms implies something at variance with the true description of the species, as contrasted with others, or retains some elements of doubt, I have chosen the succeeding title, viz. *gesserensis* (of the same author), as more appropriate. His description of the form under the latter name, and the accompanying figure, leave no room for uncertainty, even the pale specks for the exit of the reproductive elements being noticed on the sides. Müller's *Ascaris rubra* was probably a small specimen of the same worm. For some time I was inclined to include *Planaria viridis* under the present species, but the thick or almost baccate appearance of some of the figures in the 'Zoologica Danica' gives rise to so much doubt that I have not deemed it prudent to unite them. The *Planaria carnea* of Jens Rathke ('Skrivter af Naturhist. Selskabet,' &c., 5te Bd., p. 83, tab. iii, f. 10, *a*, *b*) appears to be referable to this common form. It is doubtful whether the *Lineus oculatus* of Montagu (MS.) applies to *L. gesserensis* or to *L. sanguineus*. Dr. Johnston first described the species as having two eyes, but, as Œrsted states, the author had only seen a young specimen. He afterwards gave it four eyes, but the number of the latter is of little moment, since the animals are so liable to vary in this respect. Dr. Johnston also observed the presence of the gregariniform parasites for the first time, though he did not correctly interpret their nature. The *Nemertes obscura* of E. Desor, from the coast of the United States, is allied in the closest manner to this species, and the *Nemertes flaccida* of M. van Beneden is either a pale variety of the same or *L. sanguineus*.

3. Lineus sanguineus, *Jens Rathke*. Plate V, fig. 2.

Specific character.—Eyes more regularly arranged than in the foregoing; snout narrower. Body more elongated, and of a reddish or reddish-brown hue. Regenerates easily.

Synonyms.

1799. *Planaria sanguinea*, Jens Rathke. Skrivter af Naturhist. Selsk., vol. v, i, p. 83.
1828. „ *unicolor*, Johnston. Zool. Jour., vol. iii, p. 488 (?)
1829. „ *octoculata*, Ibid. Op. cit., vol. iv, p. 56.
1837. *Nemertes* (*Borlasia*) *octoculata*, Ibid. Mag. Zool. and Bot., vol. i, p. 537, pl. 18, f. 2.
„ „ „ Œrsted. Kroyer's Naturhist. Tids., iv, p. 579, in nota.
„ *Planaria sanguinea*, Ibid. Op. cit., pp. 572 and 579, in nota.
1844. *Nemertes octoculata*, Ibid. Entw. Plattw., p. 91.
„ „ *sanguinea*, Ibid. Op. cit., p. 92.
1846. *Borlasia octoculata*, Johnston. Ann. Nat. Hist., vol. xvi, p. 434.

1846. *Borlasia octoculata*, W. Thompson. Ann. Nat. Hist., vol. xviii, p. 388 (?)
1850. *Nemertes octoculata*, Diesing. Syst. Helm., vol. i, p. 276.
„ „ *sanguinea*, Ibid. Op. cit., p. 276.
1856. „ *octoculata*, Byerley. Fauna of Liverpool, p. 98.
1860. „ *communis*, Van Beneden. Recher. sur les Turb., p. 7, pl. i, f. 1—13.
1862. „ *octoculata*, Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 63, taf. 7, f. 1 and 2.
„ „ *communis*, Diesing. Revis. der Turbell., p. 302.
„ „ *octoculata*, Ibid. Op. cit., p. 305.
„ „ *sanguinea*, Diesing. Op. cit., p. 305.
„ „ *octoculata*, Ibid. Nachträge z. Revis. der Turbell., p. 14.
1865. *Borlasia octoculata*, Johnston. Catalogue Brit. Mus., pp. 21, 287, and 290, pl. ii *b*, f. 2 and 2*.
1866. „ „ Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 388.
1867. „ „ McIntosh. Jour. Micros. Sc.; Trans., p. 39.
1868. „ „ Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
„ „ „ Ibid. Proceed. Linn. Soc., Zool., vol. x, p. 251, tab. 7.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374 et seq.

Habitat.—Under stones between tide-marks; less abundant than *Lineus gesserensis*, but having a similar range in the British Islands.

Body.—Four to eight inches long, and about a line and a half in breadth, flattened, of nearly equal diameter for some distance behind the head, and then gradually diminishing towards the tail. It is always proportionally much longer and more slender than *Lineus gesserensis*. The dorsum is crossed, sometimes at rather distant intervals, by transverse lines, which cause a dimple at each side, and it is probably at these furrows that rupture so frequently occurs.

Colour.—Various shades of red and brown. Some specimens anteriorly are of a very bright red, which becomes fainter posteriorly, the caudal region being pale brown. In the dark brown examples the ganglionic region (not the ganglia) is bright red, the succeeding portion of the dorsum dull brownish-red, and then dark brown, the latter gradually becoming paler towards the tip of the tail. The under surface is somewhat paler.

Head.—This differs from that of the former species by being scarcely wider than the succeeding portion of the body. Its posterior boundary can just be distinguished dorsally by the slight indentations at the termination of the cephalic fissures. The whole region is narrow, flattened, slightly tapered towards the tip, which is pale, and furnished with a central and two lateral papillæ, or, as the case may be, with a notch and two lateral papillæ. The eyes are placed further back than in *L. gesserensis*, are more distinctly defined, and form a regular row on each side, to the number of three or four. The lateral fissures have narrow lips, and extend from the tip of the snout backwards. The mouth opens in a pale space some distance behind the ganglia.

The worm is much longer and more slender than *L. gesserensis*, from which it is at first sight distinguished by the fine reddish coloration anteriorly. It is also a less active and restless species, and is prone to seek shelter under shells and stones, or in fissures and tubes, where it remains in a quiescent condition for weeks. It frequently lies coiled as a firm ball amongst the débris in the vessel, or loosely on the bottom, so that when the vessel is held obliquely the specimens roll from side to side. On account of these retiring habits it is somewhat difficult to get a good view of the animal. This may, however, be accomplished by transferring the hidden or coiled worm to another vessel of salt water, when the change of element generally causes it to move out of its shelter or unroll. It readily reproduces heads or other portions in fragments of its body, so that the irritation and discomfort of a long journey in a jar is found occasionally to increase rather than diminish the number of specimens. The skin is acid to litmus-paper.

L. sanguineus feeds on *Harmothoë imbricata* and other annelids in a decaying or at least dead condition.

The ova are developed in October.

After some hesitation I have referred the *Planaria sanguinea* of Jens Rathke to this species. The *Planaria unicolor* of Dr. Johnston may also be the same animal; indeed, so far as can be made out, it does not approach any other form. His preparation of *Borlasia purpurea* in the British Museum belongs to the same species. This author does not seem to have been aware that several varieties of *Lineus gesserensis* have a reddish-brown colour, when he described this hue as distinctive of the present species, yet he probably had the true *L. sanguineus* before him. M. van Beneden remarks that his *Nemertes communis* is distinguished from *L. gesserensis* by the length of the body and the double row of eyes. The latter character occurs in both species; and while his form, probably, differs from *L. gesserensis*, he does not satisfy us as to its separation from *L. sanguineus*. I have made Prof. Keferstein's *Nemertes octoculata* synonymous after some doubt, since there is little in his description to distinguish it from a pale variety of *L. gesserensis.*

4. Lineus lacteus, *Montagu*, MS. Plate V, fig. 3.

Specific character.—Snout similar to the foregoing, but the mouth is placed much further behind the ganglia. Body reddish anteriorly, pale posteriorly.

Synonyms.

1808. *Lineus lacteus,* Montagu. MS., p. 275.
1867. *Borlasia lactea,* McIntosh. Quart. Jour. Micros. Sc.; Trans., p. 39.
,, ,, ,, Parfitt. Catal. Annel. Devon. (Ext. Trans. Devonsh. Assoc. for the Advancement of Sc., &c.), p. 6.
1868. ,, ,, McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. ,, ,, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 372 et seq.

Habitat.—South coast of England, under stones between tide-marks.

Body.—One to two feet in length, rather less than a line in breadth, flattened, almost insensibly tapered from head to tail, and marked by pale transverse lines. In contraction it is rounded, and very frequently the animal advances with its body thrown into various stiff wrinkles and dilated portions.

Colour.—Uniform dull whitish or cream-yellow, with the regions before and behind the ganglia (three quarters of an inch or more) of a fine rose-pink, which gradually fades posteriorly. The coloured region behind the ganglia corresponds to the long circulatory space in front of the mouth. Snout and tail translucent.

Head.—Elongated, very slightly broader than the succeeding portion of the body, and in many positions narrower, tapered anteriorly, with the tip rather rounded, and furnished with three papillæ. It is distinguished posteriorly by a slight incurvation at the termination of the cephalic fissures, which are rather shallow. Eyes forming a nearly parallel row on each side, distinctly separated, and to the number of six or eight in each row. They are not symmetrically arranged, and a considerable translucent space exists between their commencement and the tip of the snout. The mouth is situated much further back than in *Lineus sanguineus*, to which it is otherwise closely related.

Seven or eight specimens were sent me, in October, 1866, by Mr. Parfitt, of the Devon and Exeter Institution, in a tin box, and a few are still alive (Dec., 1871), so that they exhibit the usual hardihood in confinement. In progression the head is often ribbed in a longitudinal manner. When irritated, the extended worm contracts, generally in a spiral or closely coiled manner, and sometimes in a form so regularly twisted as to resemble a rope with its strands. It advances by gentle undulations of the body, and frequently the head is rolled from side to side. The worm also readily forms itself into a knotted mass, as well as stretches to an extreme degree of tenuity. The skin presents an acid reaction.

This is one of the many discoveries made by the acute and persevering Montagu on the southern coast. There are few external characters in the description of the animal that had escaped him. It is doubtful whether Prof. Grube's *Nemertes lactea* from Villafranca ('Archiv für Naturges.,' 1851, p. 151, taf. 7, f. 3 and 4) coincides with our species. His enlarged drawing of the head has certainly many more eyes, and the orange specks on the dorsum are quite different. Moreover, it is scarcely to be supposed that this author would not mention so important a point as the distance of the mouth behind the ganglia. He states that the "mouth is rounded," and about two millimètres from the snout. Dr. Johnston's preparation of *Lineus albus*, Dalyell, in the British Museum, resembles the present species very closely.

5. Lineus bilineatus, *Delle Chiaje.* Plate VI, fig. 1.

Specific character.—Head rather rounded anteriorly; eyeless. Body pale brown or dull pinkish, with a white stripe on each side of a dorsal median line.

Synonyms.

1841. *Polia bilineata*, Delle Chiaje. Descr. e Notom. degli anim. invert., tom. iii, p. 126, tab. 103, f. 11 and 12.
1844. *Nemertes bilineata*, Œrsted. Entw. Plattw., p. 91.
1850. *Meckelia bilineata*, Diesing. Syst. Helm., vol. i, p. 264.
,, ,, *cerebratulus*, Ibid. Op. cit., p. 269.
1853. *Gordius tænia*, Dalyell. Pow. Creat., vol. ii, p. 70, pl. 10, f. 1—4.
1860. *Cerebratula Œrstedii*, Van Beneden. Recher. sur les Turbell., p. 16, pl. 2, f. 1—4.
1862. *Cerebratulus bilineatus*, Ibid. Op. cit., p. 273.
,, *Meckelia Œrstedii*, Diesing. Revis. der Turb., p. 286.
,, ,, *cerebratulus*, Ibid. Op. cit., p. 286.
1865. ,, *tænia*, Johnston. Catalogue Brit. Mus., pp. 28 and 298.
1866. ,, ,, Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.
1868. *Cerebratulus tænia*, McIntosh. Rept. Brit. Assoc., 1858, p. 340.
1869. ,, *bilineatus*, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374 et seq.

Habitat.—Generally occurs in somewhat deep water on coralline ground, or oyster-beds, but also under stones and in cracks of oyster-shells between tide-marks. The largest specimen I have seen was procured from the stomach of a haddock caught off St. Andrews Bay.

Body.—A few inches to a foot and a half in length, and of variable breadth; not much flattened, except on the ventral surface, widest in front and gently tapering towards the posterior extremity.

Colour.—Various shades of pale madder-brown, chocolate or reddish-brown, darkest in front, and gradually fading posteriorly. From the centre of the snout, just within the pale border, a white or yellowish stripe commences by a wide origin, which occupies nearly the whole breadth of the region, and proceeds to the tip of the tail along the middle line of the dorsum. It is widest anteriorly, and is rendered double by a dark central streak. Sometimes a young specimen presents an opaque white pigment-patch on each side of the usual central bands of the snout, so that by transmitted light the organ seems furnished with two large eyes. In a variety the anterior third was very pale, the rest of the body being of a bright rose or carmine colour. The under surface of the body is paler than the upper, especially towards the middle line and the region of the mouth. Specimens found in exposed places between tide-marks are darker than those from more sequestered regions.

Head.—Flattened and somewhat spathulate, rather blunt anteriorly and somewhat narrowed posteriorly at the termination of the cephalic fissures, from which a slight depression slants inwards and backwards towards the central stripes. The lateral fissures are deep, and tinted of a vivid red colour towards the pit posteriorly. The narrowing of the snout anteriorly and posteriorly gives it a somewhat elliptical or ovoid appearance. There is no trace of eyes or eye-specks. The mouth opens a short distance behind the ganglia.

L. bilineatus is rather a sluggish species in confinement, but is easily preserved alive for years. It progresses with a rolling motion of the head, but will remain for weeks in a dormant condition under a shell or in a mass of hardened mucus. The skin is strongly acid to test-paper.

I have not found specimens containing developed generative organs, but Sir J. Dalyell relates of his captives that a vast quantity of white ova, amidst a thin glairy matter, appeared in the vessel in June.

I have little doubt the *Polia bilineata* of Delle Chiaje refers to this species; and since he describes the *Cerebratulus* (*Ophiocephalus*) *bilineatus* of Renier as quite a different form, probably the same as the *Nemertes peronea* of De Quatrefages, with two dorsal black lines, I have omitted Renier's name altogether from the synonyms, for I have not been successful in seeing a copy of his early work. It is unlikely that so acute an observer as Delle Chiaje would confound the two species, especially as the published description of the first form was in his own language. Sir J. Dalyell thought the *Planaria dorsalis* of Abildgaard (*Tetrastemma dorsalis*) was probably a mutilated fragment of this worm. M. van Beneden, again, not long ago described it as a new species from deep water off the Belgian coast. I have not been able to verify this author's remark, that there are three divisions in the alimentary canal, nor have I ever seen it or any other Nemertean "threatening its prey with its proboscis." In his 'Nachträge zur Revision der Turbellarien' Diesing erroneously places Dalyell's *Gordius tænia* (the present form) under *Ommatoplea peronea*.

Genus VII.—Borlasia,[1] *Oken*, 1817.

The genus *Borlasia* was formed by Oken in his 'Lehrbuch der Naturgeschichte' for the previously named *Lineus marinus* of Montagu, and therefore very properly was disused in that instance. Instead of applying the title to represent forms belonging to the Enopla, as Prof. Keferstein and others have done, I have chosen rather to bestow it on the present new type of the Anopla, a type, indeed, not far removed from that to which the name was originally given.

Generic character.—Body round and massive, not tapered posteriorly. Snout acutely pointed. Proboscis extremely slender, furnished with elastic external, longitudinal, circular, and glandular coats. There are no accessory bands at the poles in transverse section. Circulatory fluid and muscles tinted reddish.

Borlasia Elizabethæ, n. s. Plate VII, figs. 1 and 2.

Specific character.—Eyeless; snout much tapered anteriorly. Posterior part generally contracted into a thick rugose mass. Head pale, faintly streaked with greenish brown; body mottled with deep madder-brown.

Habitat.—In a pool near low-water mark to the north of Rat Island, Herm.

Body.—About a foot in length and a fifth of an inch in breadth, rounded in extension, flattened in contraction, tapering towards the snout, and also slightly towards the tail, which ends bluntly; indeed, the posterior end generally forms a dilated mass with a dimple in the centre, and coarsely marked by transverse wrinkles. The body is seldom free from numerous longitudinal furrows, which are especially distinct anteriorly.

Colour.—The head throughout two thirds of its length anteriorly is pure white, with olive-green specks; for rather more than the posterior third, however, the deep purplish-brown and white touches of the dorsum occur. The speckled dorsum is marked at somewhat regular intervals by belts of pinkish white, which entirely surround the body. Some of the pale rings are broader than others, but there does not seem to be any regularity in this respect. They continue to the tip of the tail, but gradually grow faint posteriorly. The colours are brightest anteriorly, the greater part of the body being of a speckled olive-brown hue. A very slight reddening is noticed over the ganglionic region. The pale olive specks of the snout pass into the anterior part of the cephalic fissures, while the posterior end of each is deep red. The snout continues pale to a similar extent ventrally, while the olive-green specks are few and indistinct. The ventral surface of the body generally is somewhat paler. Captivity does not seem to affect these hues very soon.

Head.—Not distinguished posteriorly from the rest of the body, except in certain positions, when the slight elevation of the posterior fold of the cephalic fissure indicates a separation. It tapers rather abruptly to a somewhat narrow tip, furnished with a central papilla. From the angle of the tip on each side a deep lateral fissure runs to the posterior border of the snout, where

[1] In honour of the Rev. W. Borlase, the natural historian of Cornwall.

the dilated termination is conspicuous on account of its reddish coloration. A groove generally present on the side of the body is continuous with the end of the latter, but such a furrow, of course, is only one of the variable longitudinal rugæ of the body. The lips of the cephalic fissures are usually kept in apposition, except at the posterior dilated portion. The mouth commences just behind the ganglia, and forms a considerable longitudinal slit.

On turning over a large stone in the litoral pool above mentioned a piece of the tenacious grayish-white clayey mud so characteristic of the locality, and which was furnished with a smooth groove, adhered to a corner on the under surface; and on searching the now muddy pool from which the stone had been raised, the rest of the firm clayey groove and a purplish or dark madder-brown body about two inches long were found. The latter very much resembled the rough siphons of a bivalve mollusk, being flattened, transversely rugose, somewhat abruptly truncated at each extremity, hard and resilient under the touch. On placing this curious structure in pure sea-water, the head of the animal was by-and-by pushed out from the dilated mass, not by the gradual elongation of the whole, but as if an invisible power were drawing caouchouc through a fixed aperture. It was transported to Scotland without difficulty, and lived there until dissected, pushing its anterior end slowly about the bottom of the vessel, and seldom completely extending itself. Indeed, the remarkable dilatation of the posterior end, which was often enveloped in mucus, was characteristic. Sometimes, however, the stretched tail was attached to mucus at the bottom, while a dilated mass of the body remained about an inch in front of it, the rest of the animal being attenuated, and perhaps laid along the water-line. Its habits on the whole were sluggish, and corresponded with its native situation.

On taking the animal out of the water after several months' confinement it contracted itself firmly, an elliptical rent appeared on the ventral surface, and in a few seconds it ruptured into four pieces. The anterior fragment with the head lived several months longer, and during this time the posterior end had become considerably enlarged and paler, and there is no doubt the original size and shape would have been gradually attained under favourable circumstances, while its lost fragments were mounted as microscopic preparations.

The skin gives an acid reaction to test-paper.

An allied species was dredged by Mr. Jeffreys in the "Porcupine" Expedition, 1870, off Cape Finisterre, at a depth of 80 fathoms.

Genus VII.—Cerebratulus,[1] *Renier*, 1804.

The species upon which this genus in the present work rests was probably known to O. F. Müller as *Planaria angulata.* Renier in 1804, in his 'Prospetto della classe dei vermi,' established the genus *Cerebratulus* for a worm which appears to have been allied to the present form, and certainly one of the Anopla, if we may judge from Diesing's reprint of the characters given by this author. I have chosen rather to run some risk in using Renier's name than to aid in perpetuating the profuse nomenclature which arose chiefly from insufficient acquaintance with the literature and anatomy of the subject.

Generic character.—Body generally flattened, and thinned at the margins. Snout pointed

[1] *Cerebrum,* the brain; probably from the fancied resemblance of the respective tissues.

in front. Eyes obscure. Proboscis with a cross of fibres at each pole in transverse section.

Cerebratulus angulatus, *O. F. Müller*, 1774.

Specific character.—Snout pointed. Body much flattened, brownish.

Synonyms.

1774. *Fasciola angulata,* O. F. Müller. Verm. Terrest. et Fluv., vol. i, part ii, p. 58.
1776. *Planaria angulata,* Ibid. Zool. Danic. Prodr., p. 221, No. 2680.
1780. „ „ O. Fabricius. Faun. Grœnland., p. 323, No. 303.
1788. „ „ Gmelin. Lin. Syst. Nat., p. 3088, No. 9.
1798. „ „ O. Fabricius. Skriv. af Naturhist. Selskabet, 4te Bind, 2det hefte, p. 52, &c., tab. ii, f. 1—7.
1844. *Cerebratulus ? angulatus,* Œrsted. Entw. Plattw., p. 94.
1845. *Serpentaria fragilis,* H. Goodsir. Ann. Nat. Hist., vol. xv, p. 377, pl. 20, f. 1 and 2.
1850. *Meckelia serpentaria,* Diesing. Systema Helm., vol. i, p. 266.
1853. *Gordius fragilis,* Dalyell. Pow. Creat., vol. ii, p. 55, pls. 6, 7, and 7 (bis).
1857. *Lineus Beattiæi,* J. E. Gray. Proceed. Zool. Soc., pt. xxv, p. 210, pl. 48.
1858. „ *longissimus,* W. Beattie. Op. cit., pt. xxvi, p. 307.
1859. *Meckelia serpentaria,* Leuckart. Archiv für Naturges., ii, p. 187.
„ *Lineus longissimus,* Beattie. Ann. Nat. Hist., 3rd ser., iii, p. 160.
1862. *Meckelia serpentaria,* Diesing. Revis. der Turbell., p. 281.
„ „ *Beattiæi,* Ibid. Op. cit., p. 285.
1863. „ *olivacea* (*Rathke*), Diesing. Nachträge z. Revis. der Turbell., p. 8.
1865. *Serpentaria fragilis,* Johnston. Catalogue Brit. Mus., p. 28.

Habitat.—Generally in deep water throughout the British coasts. Greenland.

Body.—Fifteen inches to three feet long, and about an inch in breadth; flattened, bluntly and rather suddenly tapered in front, more gradually posteriorly, and thinned at the margins all round, so that a transverse section of the contracted body is elliptical.

Colour.—Universally gray, darker on the dorsal, paler on the ventral surface, and with a pale margin. Sir J. Dalyell's figure has a brown stripe commencing at the anterior third, and continuing to the tip of the tail, and the divisions of the alimentary organ are indicated inferiorly, but of course we must be cautious in making deductions therefrom. This author also observes that in one of his specimens a portion of the edge was reddish, a colour in all probability due to the nerve-trunk and its surroundings. Mr. Goodsir states that his example was of a slate-blue colour, with a yellowish edge.

Head.—Tapered to a blunt snout in front, with a cephalic fissure on each side, and apparently without eye-specks. Mouth forming a large slit on the ventral surface in the usual position.

I have referred this species to the *Planaria angulata* of O. F. Müller, from a careful consideration of all the circumstances connected with its history, including the examination of several examples from the north sea, and named by northern naturalists. Müller's account of its size, the pointed nature of its snout, its colour and other points, can scarcely apply to any other species; and in the preparations the flattened body, thinned edges, and the structure of the proboscis are quite characteristic. The late Mr. Harry Goodsir mentions that, "when swimming, the animal is very active, and advances with considerable rapidity by means of an undulatory serpentine motion. When handled it throws itself into various contortions, and instantly casts off numerous annuli from the posterior part of its body, each of which, immediately upon its separation from the original, begins to move in a similar manner." Sir J. Dalyell afterwards made like observations, and noted that the animal was full of a yellow substance, a remark which probably applied to the wall of the digestive cavity, the same colour being present in *Micrura fusca.* He also found numerous white ova discharged from a fragment in May. The *Lineus Beattiæi* of Dr. Gray, and the *L. longissimus* of Mr. Beattie, appear to belong to this species, if we may judge from the preparation of the former and the proboscis of the latter in the British Museum. Mr. Alex. Agassiz mentions that he found the *Planaria angulata* of O. F. Müller on the under surface of the tail of *Limulus,* but of course this refers to quite a different form, probably to a *Planaria.*

This species is very closely allied to *Micrura fusca;* and if the structure of the proboscis had not deviated so distinctly I should have been inclined to unite them.

Genus VIII.—Micrura,[1] *Ehrenberg,* 1831.

As has occurred in several instances, the typical form was known to the veteran naturalist O. F. Müller, as well as to Col. Montagu. Ehrenberg, however, separated the genus from others for the first time in his 'Symbolæ Physicæ,' and gave a good figure of *M. fasciolata,* though he was unaware that the same form had previously been observed by others.

Generic character.—Body not much elongated. Head distinctly marked, snout truncated. Other characters as in *Lineus,* with the addition of a caudal process or style capable of attachment.

1. Micrura fusca, n. s. Plate VI, fig. 3.

Specific character.—Eyes four to eight on each side, small. Body much flattened and thinned at the edges; speckled with brownish grains on the head and anterior region.

Synonym.

1869. *Micrura,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 376, &c.

Habitat.—Not uncommon amongst the débris from the coralline ground in fishing boats, amidst oysters and tangles in the laminarian region in Shetland, under stones between tide-marks at Herm, and at a depth of 795 fathoms off the coast of Portugal.

Body.—Two to four inches in length, slightly tapered towards either extremity, flattened both

[1] Μικρὸς, small or slender, and οὐρὰ tail. Strickland applied the same title to a genus of Certhidæ in 1841 ('Ann. Nat. Hist.').

dorsally and ventrally, and furnished with a pale caudal filament. It is frequently marked by transverse lines or slight furrows.

Colour.—Pale skin, ash or brownish; dorsum speckled with pale brown touches, especially distinct over the head, which has also a well-marked reddish hue in the ganglionic region. A little within the pale margin of the body a pinkish streak occurs on each side from the coloration of the nerve-trunks. Posteriorly the lateral divisions of the dull yellowish digestive tract shine through the skin. Ventral surface of a pale skin-colour, also enlivened by the coloration of the nerves, and in some cases with a few pale brownish specks anteriorly. The caudal style occasionally shows a few white grains in the central line towards the base.

Head.—Spathulate, but much pointed towards the tip, dilating from the latter backwards to the termination of the cephalic fissures, the whole region being peculiarly hastate. Eyes small, black, grouped on each side of the pointed snout, and varying in number from four to eight on each side. The lateral fissures are deep, and have the reddish hue very brightly marked posteriorly.

This is one of the flattest among the shorter species of the group, both before and after preservation in spirit. During life it swims through the water on its edge, with an eel-like wriggle, similar to that of *A. pulcher*, but somewhat less vigorously. When progressing the margins of the body are often very prettily frilled, the reddish longitudinal lines just within the pale border increasing the effect. It is rather irritable, throwing out its yellowish proboscis when touched, or breaking into several fragments. The former clings closely to the finger by means of its tenacious secretion.

It fixes the tip of its caudal process as in *M. fasciolata*, and elongates it so as to resemble a very fine thread, which, however, is slightly moniliform. It agrees in minute structure with the foregoing, and, when detached from the worm, much resembles a long *Opalina*, or other ciliated organism, in facile and independent movements.

The skin presents an acid reaction to test-paper.

I at first thought that this form was only a small variety of the great *Gordius fragilis* of Dalyell (the previous species), and future investigators may establish a closer relation between them than I have been able to make out. I did not feel justified, however, in uniting them, on account of the remarkable difference in the structure of the proboscis, which in *M. fusca* has the anatomy characteristic of *Lineus*, while the double isolated longitudinal bands at one of the poles in transverse sections of the organ in *C. angulatus* exhibit quite a new feature.

No author, so far as I am aware, has mentioned the caudal process in the last species, but this is a point which may have been easily overlooked.

Whether the young animal shown in Plate VI, fig. 4, is an early condition of this or an allied species I am unable to decide. It was one of the novelties found by its artist during one of her trips to St. Andrews in the spring of 1866.

2. Micrura fasciolata, *Ehrenberg*. Plate VI, fig. 2.

Specific character.—Eyes marginal, placed towards the anterior part of the snout. Body various shades of brown, generally barred with white belts.

SYNONYMS.

1788. *Planaria filaris,* O. F. Müller. Zool. Danic., ii, p. 38, tab. 68, f. 18—20.
„ „ „ Gmelin. Linnæus Syst. Nat., tom. i, pars vi, p. 3093.
1808. „ *lineata,* Montagu, MS. tab. 56, f. 5.
1831. *Micrura fasciolata,* Ehrenberg. Symb. Phys., Phyt. Turb., No. 15, tab. 4, f. 4, *a—i.*
1827. *Planaria filaria,* Bosc. Hist. Nat. des Vers., i, p. 261.
1844. *Nemertes pusilla,* Œrsted. Entw. Plattw., p. 90.
„ „ *fasciolata,* Ibid. Op. cit., p. 91.
„ „ *pusilla,* Ibid. Kroyer's Nat. Tids., iv, i, p. 578 (partim).
„ „ „ Ibid. De Region. Marin., p. 80.
1847. *Pylidium gyrans* (young form), Müller. Archiv für Anat., p, 159, taf. 7, f. 1—4.
1850. *Micrura fasciolata,* Diesing. Syst. Helm., vol. i, p. 261.
„ *Nemertes pusilla,* Ibid. Op. cit., p. 271 (partim).
1851. *Pylidium gyrans,* Busch. Beobachtungen über Anat., &c., p. 107, taf. 16, f. 1—8.
„ *Alardus caudatus,* Ibid. Op. cit., p. 111, taf. 11, f. 8.
1853. *Gordius fragilis spinifer,* Dalyell. Pow. Creat., vol. ii, p. 79, pl. 11, f. 5 (var.).
„ „ *fasciatus spinifer,* Ibid. Op. cit., p. 80, pl. 11, f. 6—15.
„ *Alardus caudatus,* Müller. Abhandl. Berl. Akad. (1852), p. 59.
1854. *Pylidium gyrans,* Gegenbauer. Zeitsch. für wiss. Zool., v, p. 345.
„ „ „ Müller. Archiv, p. 75, taf. 4, f. 2—8.
„ *Alardus caudatus,* Ibid. Op. cit.
1858. *Pylidium gyrans,* Krohn. Müller's Archiv, p. 289.
„ *Alardus caudatus,* Ibid. Op. cit.
„ *Micrura filaris,* Müller. Archiv, p. 330 (note).
1861. *Pylidium gyrans,* Claparède. Recher. Anat. sur les Annel., Turb., &c., p. 54, pl. 5, f. 3 and 4 (?)
1862. *Micrura fasciolata,* Diesing. Revis. der Turbell., pp. 258—260.
„ „ *filaris,* Ibid. Op. cit., p. 260.
„ *Meckelia cœca,* Ibid. Op. cit., p. 286.
„ *Nemertes pusilla,* Ibid. Op. cit., p. 298.
1863. *Micrura fasciolata,* Diesing. Nachträge z. Revis. der Turbell., p. 7.
1865. *Stylus fragilis,* Johnston. Catalogue Brit. Mus., pp. 24 and 293.
„ „ *fasciatus,* Ibid. Op. cit., pp. 24 and 293.
1869. *Micrura fasciolata,* McIntosh. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374.

Habitat.—In fissures of the rocks near low water, in the coralline region, and oyster-beds. Ranges from the Shetland Islands to the Adriatic.

Body.—Four to six inches in length, and about a line in breadth, flattened on the ventral surface, about as much tapered anteriorly as posteriorly, and with a slender styliform process attached to the tail.

Colour.—Fine reddish brown of various shades, banded across with white belts at somewhat regular intervals, and with the tip and sides of the snout pale. The styliform process is pale and translucent. Ventral surface paler than the dorsal, but also inclining to reddish brown, and marked by distinct lines or furrows, which are continuous with the white dorsal bands. The first white dorsal belt usually occurs a little behind the termination of the cephalic fissures, but occasionally the presence of some dark red pigment near the tip of the snout cuts a stripe off the pale portion. The white bars are sometimes lozenge-shaped, from a dilatation in the middle. Some specimens from the coralline ground off St. Andrews are of a very pale brown or fawn colour on the dorsum, darkest in front, without white stripes, the only markings being the transverse wrinkles of the body. The pale portion at the tip of the snout, and especially its margins, are increased in breadth; the latter, indeed, being continuous with a pale lateral border (not due to the cilia) throughout the entire length of the animal. The under surface in such examples is of a dull whitish hue, with the exception of the reddish ganglionic region. A dull olive variety of large size (six to ten inches) also occurs in the recesses of the tangle-roots in the Shetland Islands. Some of the examples with white bands have also a whitish ventral surface; and occasionally the bands, even when present, are very inconspicuous.

Head.—Somewhat spathulate, flattened, tapered towards the front, which is rounded and furnished with a central papilla, wider than the rest of the body. There is a deep lateral fissure on each side, with a reddish coloration posteriorly. Just within the pale margin of the snout are numerous eyes, those in front being best seen from the dorsum, especially in pale specimens, and also from the cephalic fissures. They form a single converging row on each side, to the number of eight or twelve. Young specimens are furnished with two conspicuous eyes only. The mouth occupies the usual position behind the ganglia.

This is one of the most beautiful Nemerteans, from the striking contrast in its colours and the soft and velvety aspect of its skin. It is evidently a dweller in crevices, and has a great tendency to hide under débris or other shelter in glass vessels; and if this protection be denied it, the animal frequently coils itself in a mass, either with or without enveloping mucus. Some are hardy in confinement and live for years, others are irritable and fragile, breaking themselves on the slightest interference into many fragments, the separation almost always occurring at the white belts. This rupture often takes place before they are removed from the collecting-bottle, especially if they do not have it all to themselves. Fragments of the posterior end of the body turn slowly in the vessel, and live a long time. Of the two well-marked varieties, viz., the banded and the uniformly tinted, the latter are the less fragile, and their bodies are more flattened. The styliform process at the tail can be elongated to an extreme degree. The skin presents an acid reaction.

The spermatozoa are fully developed in the beginning of November, causing pale transverse bars at the sides of the males. The same elements are fairly matured in Zetlandic examples in August.

It is doubtful whether the *Fasciola caudata* of O. F. Müller has any connection with this species, especially as it was found by O. Fabricius gregariously associated amongst litoral fuci on the shores of Greenland. The same author's *Fasciola flaccida* has closer resemblances both in description and figure; though, as regards the transverse white lines, it is to be remembered that he gives the same account of *F. viridis.* His figure and the remark concerning the fragility of the species show a close affinity. The *Planaria filaris* of this author, again, may be regarded as a young specimen, though he represents the tail too elongated. He found it on *Madrepora prolifera.* Montagu observes that the colour of his specimens (*Planaria lineata,* Mont. MS.) was "rufous brown, with about ten white lines across the back. Beneath pale, without the lines." The *Planaria rufa* of the same naturalist (MS., p. 232) is either a uniformly tinted example of this species, or a variety of *Lineus gesserensis.* It was found on a large oyster. Ehrenberg gave a good description and figure of the animal from specimens found in the Adriatic. He mentions the presence of five eyes on each side, and that the ovarian aperture (mouth) lies under the second dorsal white bar. He also alludes to the copious exudation of mucus with which it forms a sheath. I have followed J. Müller in including the young form, *Pylidium gyrans,* under this species. Dalyell observed that his specimens (*Gordius fasciatus spinifer*) had a tendency to rupture at the white belts. Moreover, his examples reproduced bodies to the anterior regions, but no heads on the posterior fragments, though he did not doubt that regeneration would ensue in every case under more favourable circumstances. His *G. fragilis spinifer* is probably a specimen of this species uniformly tinted, and its subsequent fracture into many pieces is corroborative of this view. I am in doubt, however, whether his *G. viridis spinifer* (op. cit., p. 78, Pl. XI, f. 1) is a distinct form or only a variety of this or the succeeding species.

The *Meckelia annulata* of Grube, and the *M. Knerii* of Diesing, are closely allied to the foregoing. The absence of the caudal process in the former may have been accidental, while, as regards the latter, Prof. Grube may be wrong in supposing such only a reproduced tail.

3. Micrura purpurea, *Dalyell*. Plate VII, fig. 3.

Specific character.—Eyeless. A bright yellow patch at the tip of the snout. Body of a uniform rich dark brown colour.

Synonyms.

1853. *Gordius purpureus spinifer,* Dalyell. Pow. Creat., vol. ii, p. 78, pl. 11, f. 2—4.
1858. *Micrura purpurea,* J. Müller. Archiv, p. 300.
1862. „ „ Diesing. Revis. der Turbell., p. 260.
1865. *Stylus purpureus,* Johnston. Catalogue Brit. Mus., pp. 24 and 293.
1868. „ „ McIntosh. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. *Micrura purpurea,* Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 374, &c.

Habitat.—In fissures of rocks near low water, and between the valves of empty shells, or other crevices of the débris from the coralline ground on the east coast of Scotland. It seems to be generally diffused, and occurs of large size off the Shetland Islands.

Body.—Five to eight inches in length, flattened, slightly narrowed behind the head, and gradually tapered towards the rather blunt tail, from which the styliform process arises.

Colour.—Rich dark brown with a purplish lustre on the dorsum. The tip of the snout is pale, and immediately behind is a well-defined crescentic granular yellow patch. The convexity of the latter is directed forward. In some specimens the anterior margin of the patch only is yellow, while the rest is yellowish white or pure white. There is a slight reddish hue at the ganglionic region. The styliform process is pale brown. The ventral surface is very slightly paler than the dorsal, and from the translucency of the snout the yellow pigment-patch on the upper surface shines through.

Head.—With a truncate anterior margin which is also broad, so that it has a peculiar spade-shaped appearance, slightly wider than the succeeding portion of the body, and with three papillæ in front, a central and two lateral, the latter being small and inconspicuous. The lateral fissures are deep and well marked, the bottom tinted red posteriorly, and having anteriorly some yellowish grains continued from the pigment-patch of the snout. There is no trace of eye-specks.

Micrura purpurea appears for the most part to be a deep-water species. In regard to colouring it is one of the most striking of the group, the bright yellow patch in front and the ever-varying purplish lustre of the cilia on the deep brown body forming manifold contrasts, at once pleasing and novel. It is active and voracious, and it is dangerous to leave two in the same vessel, especially if there is disparity in size, as the stronger devours the weaker. Like many of its allies, grave injuries are borne with impunity; thus a specimen which had been so severely wounded in January that it divided itself behind the head, reproduced early in May a small but complete body, furnished with the usual caudal styliform process, and this without a single renewal of the sea-water in the vessel. The head had diminished much in bulk, but was still the widest part of the animal. The body measured an inch and a half after nine months' growth. The introduction of a fresh and hungry specimen from the coralline region proved fatal to this example. The posterior end of the ruptured worm also lived many months, turning slowly round on the bottom of the vessel, and showing a pointed process above the aperture of the digestive chamber in front, while the ova in its interior had arrived almost at complete development in April.

Sir J. Dalyell procured the first specimen of this species from Shetland, and so introduced it to science and our fauna. He also figures an example with reproduced (pale) anterior and posterior extremities. Few authors seem to have observed this form, the above, indeed, being the only published notice I have been able to identify. This is the more remarkable, as it has frequently been sent from St. Andrews in the débris of the fishing boats on their return from deep water.

4. Micrura aurantiaca, *Grube.* Plate VII, fig. 4.

Specific character.—Eyeless. A white patch at the tip of the snout. Body rounded, and of a fine brick-red hue.

Synonym.

1855. *Meckelia aurantiaca,* Grube. Archiv für Naturges., p. 148, pl. 7, f. 1.

Habitat.—Under stones in tide-pools to the north of Rat Island, Herm.

Body.—Three or four inches long, rather rounded on the dorsum and flattened inferiorly. A small caudal process or filament, as indicated in the figure, was noticed during delineation, but this was not present when I examined it subsequently.

Colour.—Dorsum fine brick-red, with a roseate lustre here and there from the cilia, and having a white patch a little behind the anterior border of the snout. The reddish pigment in front of the white spot is somewhat deeper in tint than the rest of the body. The under surface is pinkish-white.

Head.—Scarcely wider than the succeeding portion of the body, somewhat flattened, slightly narrowed towards the front, and with rather shallow lateral fissures, the upper lip of the latter projecting over the lower. No eye-specks are visible. The mouth forms an indistinct slit in the usual position.

In minute anatomy this species strictly agrees with the Lineidæ. The cells of the cutis are very distinctly marked, and the subjacent pigmentary region has a fine reddish hue on the dorsum.

The layer of longitudinal fibres underneath the latter is powerful. The proboscis is white, and furnished with small glands, somewhat like those in *L. gesserensis*.

Several specimens were brought alive to Scotland, but from their fragility they were in an imperfect state. After surviving a fortnight they deposited eggs, and died about the middle of September. It was interesting to observe the change of colour which ensued in certain fragments after rupture; inferiorly they were dull brownish-red, with the pinkish-brown ova projecting in masses, but by-and-by the latter were extruded, and the ruptured ends and the inferior surface resumed the usual whitish hue of the walls of the digestive chamber. On the whole they were inert animals, generally fashioning tubes on the side of the vessel and remaining therein.

I have incorporated the British form with Prof. Grube's species from Villafranca. His description is as follows:—"Body rounded, not changeable, 1—1·5 inch long, contracting into 7·5 lines long, and then ringed and wrinkled, 0·5 of a line broad. Orange-red, or sometimes brick-red, sides and under surface white; head white, only at the tip of the snout there is a violet spot, and then a broad white belt. The body tapers towards the posterior end, and terminates in a much thinner process, probably a short reproduced tail. The head is not pointed: lateral fissures and eyes not noticed." He had overlooked the lateral fissures, which are shallow. The description of the "growing tail" quite corroborates the correctness of my sister's drawing, for the styles had fallen off when I examined the specimens. Grube's figure shows a broader white belt anteriorly than I observed in the British forms, but such may have been due either to variation or want of scientific accuracy in his artist.

Genus IX.—Meckelia,[1] *Leuckart,* 1827. (Char. emend.)

For the curious form described in the following paragraphs I have thought it better to appropriate the title of a genus established in 1827 by Leuckart in his 'Breves Animalium,' and set at liberty by the undisputed claim of priority. The name, it is true, was given to a form differing in some respects from the following; but the literature of the subject is already so burdened with generic names which have been fashioned on insufficient and unreliable data, that it is almost a duty to resent any addition thereto if it can be avoided. Priority, also, gives the present title a certain claim on our consideration.

Generic character.—Structure of the rounded body-wall as in *Lineus*. Cephalic fissures absent. Proboscis furnished with only three coats, external spiral, longitudinal, and glandular.

Meckelia asulcata, n. s.

Specific character.—Eyeless. Body thick and round. Of a uniform pinkish hue.

Habitat.—St. Magnus Bay and adjoining seas, Shetland; and between tide-marks, Herm.

[1] Named in honour of Prof. Meckel. The same name was in 1830 given by Robineau-Desvoidy ('Essai sur les Myodaires') to a genus of Diptera.

This species can be only imperfectly described at present, as its distinction was not recognized on the sole occasion on which it was seen alive. The specimen found at Herm was of a rose-pink colour in front, pale posteriorly. There are no lateral fissures on the head. The mouth lies on the ventral surface some distance behind the tip of the snout, and in the preserved specimens forms a small puncture or dimple. The worm appears to attain the length of four or five inches.

Numerous specimens of an elongated example of the Anopla without lateral fissures occur in a collection brought by the Rev. L. Guilding from the West Indies, and now in the British Museum. All have a peculiarly corrugated and thickened anterior end, and a small round mouth like a puncture. Some measure about fifteen inches long.

Family III.—Carinellidæ.

Genus X.—Carinella, *Johnston*, 1833.

Before the time of Dr. Johnston the typical animal of this genus, the *Gordius annulatus* of Montagu, had not been sufficiently distinguished from its congeners; and though he named the species in ignorance of the prior observations of Montagu, yet his generic title is more appropriate than that of *Meckelia,* in favour of which the original name was suppressed. The latter term was given to one of the Lineidæ, while the type here is totally different. *Carinella,* as its originator says, labours under the disadvantage of being a name which the scholar may "in vain puzzle himself" to find out "from what, and whence, it is derived." At first sight it seems to be a diminutive of *carina,* a keel.

Generic character.—Body elongated, tapering from the front backwards. Snout wider than the rest of the body, bluntly rounded anteriorly. Mouth sometimes small.

1. Carinella annulata, *Montagu*, 1804. Plate VII, fig. 5; and Plate VIII.

Specific character.—Eyeless, with a white patch on the snout. Body rounded, of a rich red colour, striped longitudinally and banded across at somewhat regular intervals by white belts. Occasionally pinkish throughout.

Synonyms.

1804. *Gordius annulatus,* Montagu. Linn. Trans., vol. vii, p. 74.
1807. „ „ Turton. Brit. Fauna, p. 130.
1808. *Lineus annulatus,* Montagu. MS., p. 273, tab. 9, fig. a.
1812. *Gordius annulatus,* Pennant. Brit. Zool., vol. iv, p. 73.
1833. *Carinella trilineata,* Johnston. Loudon's Mag. Nat. Hist., vol. vi, p. 232, woodcut, f. 24, *a. b.*
1841. „ „ W. Thompson. Ann. Nat. Hist., vol. vii, p. 482.
„ *Gordius annulatus,* Ibid. Op. cit., p. 482.
„ *Polia crucigera,* Delle Chiaje. Descriz. e Notom. anim. invert., &c., tom. v, p. 40, tab. 174, f. 15—18, and tab. 176, f. 17.

1846. *Meckelia trilineata,* Johnston. Ann. Nat. Hist., vol. xvi, p. 435.
„ *Valencinia ornata,* De Quatrefages. Ann. des sc. nat., 3me sér., Zool., tom. vi, p. 187, tab. 10, f. 4 and 5.
1849. „ „ Ibid. Voyage en Sicilie, vol. ii, p. 99, pl. 10, f. 1—3.
1850. „ *annulata,* Diesing. Systema Helm., vol. i, p. 244.
„ „ *ornata.* Ibid. Op. cit., p. 244.
1853. *Gordius anguis,* Dalyell. Pow. Creat., vol. ii, p. 85, pl. 10, f. 7—10, and pl. 13.
1854. *Valencinia ornata,* Müller. Archiv, p. 83.
1859. „ „ Leuckart. Archiv für Naturges., ii, p. 187.
1861. „ „ Grube. Ausflug nach Triest u. dem Quarnero, pp. 35 and 129.
1862. „ „ Diesing. Revis. der Turbell., p. 252.
„ „ *annulata,* Ibid. Op. cit., p. 253.
1863. *Valencinia ornata,* Diesing. Nachträge z. Revis. der Turbell., p. 6.
1864. „ „ Grube. Die Insel Lussin u. ihre Meeresfauna, p. 94.
1865. *Meckelia annulata,* Johnston. Catalogue Brit. Mus., pp. 27 and 296-8, with woodcut, as in 1833.
1866. „ „ Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 389.
1867. „ „ Parfitt. Catal. Annel. Devon, p. 8.
1868. „ „ McIntosh. Rept. Brit. Assoc., 1868, p. 340.
1869. „ „ Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 372 et seq.

Habitat.—Under stones near low water, in obscure fissures of rocks, and also dredged in somewhat deep water. Often cast on shore amongst débris from the laminarian region. Generally diffused round the British coasts and the shores of France. In laminarian and coralline regions it prefers tangle-roots, the inner surface of bivalve shells, or the tubes of *Terebellæ, Serpulæ,* and other annelids.

Body.—Seven to thirty inches long, and about a line in breadth, somewhat narrowed behind the cephalic furrows, and gradually tapering to the tail. Dorsal surface rounded, ventral flattened.

Colour.—Various shades of brick-red, brownish-red or vandyke-brown (garnet-red, Montagu), and with a very regular arrangement of white stripes. The snout usually has a patch of white, with a crescentic margin anteriorly and posteriorly, so as to be narrowed in the middle, with a coloured portion in front. From the former a white central line proceeds backwards on the dorsum to the tip of the tail. A short distance behind the ciliated furrows of the head a circular white belt environs the body, and from each side of this ring a white stripe passes along the lateral aspect to the tip of the tail. At certain intervals, only two of which in front are distant, the body is encircled by white rings, which give a somewhat regularly segmented appearance to the elongated worm. Posteriorly, indeed, they are often equidistant, and in many there is a pale intermediate ring, sometimes faintly indicated by whitish pigment on the dorsum. Every alternate white ring in most of the specimens is double; that is, divided by a slight furrow. Col. Montagu mentions 220 as the number of white rings after the third, and Sir J. Dalyell counted 200 belts in a specimen eighteen inches long. There are likewise in many a series of white specks above the lateral white lines, generally commencing at the fourth or fifth space behind the cephalic furrows, though occasionally some occur on the third. These indicate for the most part the points at which the products of the generative organs escape. The under surface is paler than the upper. The ventral aspect of the snout has a white patch continuous with, but narrower than, that on the dorsum. The only other markings on this surface are caused by certain pale lines and the circular white belts; but in a characteristic variety a median white stripe passes along the entire belly from tip to tip. The space behind the first white circle is usually paler than the rest. In a very large dark specimen, sent from Montrose by Dr. Howden, the white stripes anteriorly had a beautiful rose-pink shade. Pale red examples from fissures of rocks, when placed in glass vessels, gradually become brownish-red or quite brown by exposure to light.

Head.—Horseshoe shaped, wider than the rest of the body, not much flattened, and without eye-specks. Posteriorly it is gradually narrowed to the cephalic furrows, where a slight shoulder occurs. There is a curved streak in the bend of each ciliated furrow on the dorsum, perhaps in connection with the cephalic sac. These furrows are continued straight inwards on the ventral surface, so as to meet just at the anterior part of the mouth. The latter forms a longitudinal slit somewhat less distinct than in *Lineus.*

A well-marked southern variety occurs in the island of Herm. The head is peculiarly flattened, larger in proportion than in the common form, and pale at the tip. At first sight the body appears to be dull orange throughout, but minute inspection shows a pale lateral line on each side, with a series of minute pale spots above it, and traces of faint transverse bars on the dorsum.

This species, one of the most handsome and graceful of the whole order, lives a long period in confinement, constructing on the bottom and sides of the vessel numerous hyaline transparent tubes, in which it lies either doubled or coiled in various ways. The tube or case has a fine silky lustre or iridescence, appearing under a high power as an almost structureless membrane with a few minute adherent granules, and irregularly streaked with fine lines, from microscopic folds of the very thin tissue. The animal progresses somewhat slowly; and though devoid of eyes, it needs but a touch to become aware of the proximity and apparently the nature of any object, so that, for instance, it at once enters head foremost or backs into a tube. Small fragments of the body survive a long time, and move slowly about. In these the anterior end is somewhat pointed. Probably they develop into perfect animals under favourable circumstances.

The skin gives a marked acid reaction.

This is another addition to our marine fauna for which we are indebted to the industry and enthusiasm of Col. Montagu. He distinguished the common form and that with the ventral median white line, as well as noticed the white specks at the sides and the broader nature of some of the circular white belts. In the variety with the ventral longitudinal line he states that "the first annulation of white is very close to the anterior end, the second is distant about an inch, and the rest (about 220) are nearly equidistant." The drawing accompanying the manuscript by some accident shows dark instead of white lines on the dorsum. Four succeeding authors of note, viz. Dr. Johnston, Sig. Delle Chiaje, M. de Quatrefages, and Sir J. Dalyell, each described the same animal as a new species. M. de Quatrefages based the distinction of his *Valencinia ornata* from Col. Montagu's form on the fact that the latter did not note the remarkable enlargement of the head, and because his specimens came from the laminarian region, Montagu's from the coralline. Such data, of course, are unsatisfactory. Moreover, since we observe that a species so prominently barred as *Micrura fasciolata* occasionally presents none of these characteristic markings, and that the variety of *Carinella annulata* from Herm showed few traces of stripes, we may be forgiven if we harbour some doubts as to the specific distinction of De Quatrefages' two species *ornata* and *splendida.* It is possible that *Tubulanus elegans* and *T. polymorphus* of Renier, Delle Chiaje, and others, may also have some connection with this species. Sir J. Dalyell compares *C. annulata* to a regular snake in miniature, of delicate form and proportions, and decked in lively colours. He observes that the mouth is at the very extremity, and opens by a wide horizontal gape, as if the creature had an upper and an under jaw, statements due to some erroneous recollections. He notices that a large number of reddish-brown ova were discharged from a specimen in June. M. de Quatrefages, again, mentions that specimens of his *Valencinia splendida* from Bréhat were loaded with ova in September and October.

2. Carinella linearis, *Montagu*, MS.

Specific character.—Eyeless. Head spathulate, somewhat pointed in front. Milk-white.

Synonym.

1808. *Lineus linearis.* Montagu, MS., pp. 274-5.

Habitat.—South coast of England, and Lochmaddy in the Hebrides, amongst sand at low water.

Body.—Five to six inches long, less than a line in breadth, flattened, slightly tapered towards the front, diminishing more decidedly posteriorly.

Colour.—Pure milk-white, with translucent margins towards the tail.

Fig. 13.

Anterior extremity of *Carinella linearis.*

Fig. 14.

Carinella linearis with the anterior end somewhat contracted.

Head.—Spathulate, assuming various aspects, sometimes pointed (woodcut, fig. 13), at others blunt and rounded (woodcut, fig. 14). The snout has an opaque-white central streak. No pigment-specks are present.

The species was procured whilst digging for *Priapulus caudatus* and Annelids at Lochmaddy. Its habits and motions are like those of other species. As usual with white forms, immersion in spirit gives a yellowish hue. On transverse section its anatomy is found to agree with the foregoing, and especially with the variety from Balta having the bifid proboscis, for the inner (longitudinal) muscular coat of the body-wall shows a marked tendency to separation in the middle line of the dorsum.

I was inclined to consider this species a doubtful variety of *Carinella annulata* until I saw the manuscript of the accomplished Montagu containing the description of "*Lineus linearis*." He says—"*L. linearis*, with a cream-coloured body. Long, slender, considerably extensible and tenacious; the anterior end largest, sometimes clavated and flattened, at other times pointed; frequently that part is observed to be alternately inflated and contracted, while the rest of the body is quiescent. Length 5 or 6 inches when extended, but usually contracted to 3 or 4. This species inhabits the sandy shore at Dawlish, about five or six inches beneath the surface at low water. Like the *marinus*, its motion consists of contortion and variation in size of different parts of the body at the same time. A tenacious slime exudes from its body, which, collecting sand, readily forms a covering like a Sabella."

The *Valencinia longirostris* of M. de Quatrefages has certain affinities with this form, although the snout, as shown in his figures, is much more pointed. It is to be remembered also that he found his species in a similar region and medium (sand and mud) at the *îles Chausey*. The *Lineus albus* in the British Museum is one of the *Lineidæ* from Cornwall.

The shape of the head of this animal, the absence of eyes, its habit of residing amongst sand, and other points, make it clear that there are grounds for specific distinction.

Genus XI.—Valencinia, *De Quatrefages*. (Char. emend.)

This genus was instituted by M. de Quatrefages for the typical and other forms of the previous genus, but lapses in virtue of the priority of other names. Since the term was applied to an allied form, it may not inappropriately be used for the description of the present species. The genus *Polia*, perhaps, has prior claims, but it is already employed by the entomologists.

Generic character.—Structure of the proboscis as in *Carinella*. The nerves lie in the longitudinal muscular coat. The snout is shaped as in *Lineus lacteus*, and furnished with a row of eyes on each side. The mouth forms a distinct fissure a considerable distance behind the ganglia.

Valencinia lineformis, n. s.

Specific character.—Roseate in front, yellowish-white posteriorly.

Habitat.—Amongst shell-gravel and the fine purplish ramose form of *Corallina officinalis* in five fathoms, Bressay Sound, between the Point of Scotland and the Green Head.

Body.—Six to eight inches or more in length, and about a line in breadth, generally resembling that of *Lineus lacteus,* except in the greater tendency to encircling furrows.

Colour.—Richly roseate in front, the rest of the body being pale pinkish-yellow or yellowish-white.

Head.—Spathulate, as in the above-mentioned species, the lateral fissures, of course, being absent. The eyes are also fewer in number and smaller, but similarly arranged. The mouth is large and situated far backwards, the position and size being equally interesting in this group.

So like was this species to *Lineus lacteus* (Plate V, fig. 3), that most examples were consigned to spirit before a more critical examination discovered the essential differences. Those specimens, even, which were destined for transmission southward proved so delicate as to break into short fragments in a day or two. The structure of the body-wall and the proboscis at once distinguishes it from the *Lineidæ,* while the fact that the nerves in the longitudinal muscular coat do not quite reach its outer border separates it from its ally *Carinella linearis.*

Family IV.—Cephalothricidæ.

Genus XII.—Cephalothrix,[1] *Œrsted,* 1844.

This genus was established by A. S. Œrsted in his 'Entwurf Plattwürmer' for the reception of animals identical with the *Planaria linearis* of Jens Rathke. The typical form was distinguished by several names, and a variety included also under the genus *Astemma* of the same author, for I consider the distinctions as to the presence or absence of eye-specks and the vague remarks about respiratory fissures of little consequence.

Generic character.—Head cylindrical, slightly tapered in front; eyeless, or with a few obscure pigment-specks. Cephalic fissures and sacs absent. Mouth situated a considerable distance behind the snout.

Cephalothrix linearis, *Jens Rathke.* Plate IV, figs. 4 and 5.

Specific character.—Body extremely attenuated, pale yellowish or skin-colour; often with reddish grains towards the tip of the snout.

Synonyms.

1799. *Planaria linearis,* Jens Rathke. Skrivter af Naturhist. Selsk., v, p. 84, tab. 3, f. 11.
1829. „ *filiformis,* Johnston. Zool. Jour., vol. iv, p. 56.
1837. *Nemertes* (*Borlasia*) *rufifrons,* Johnston. Mag. Zool. and Bot., vol. i, p. 538, pl. 18, f. 4 and 5.
1844. *Cephalothrix bioculata,* Œrsted. Entw. Plattw., p. 81, woodcut 12.
„ „ *cæca,* Ibid. Op. cit., p. 81, tab. 3, f. 39.
„ „ *linearis,* Ibid. Op. cit., p. 82 (note under *C. cæca*).

[1] Κεφαλή, the head, and θρίξ a hair. There is a genus of Lamellicorn beetles (established by Hope in 1837) called *Cephalotrichia.*

1844. *Astemma rufifrons,* Œrsted. Op. cit., p. 82, woodcut 13 (?)
,, *Cephalothrix bioculata,* Ibid. Kroyer's Nat. Tids., iv, p. 573.
,, ,, *cæca,* Ibid. Op. cit., p. 574.
,, *Planaria linearis,* Ibid. Op. cit., p. 573.
,, *Astemma rufifrons,* Ibid. Op. cit., p. 574.
,, ,, *longum,* Ibid. Op. cit., p. 574.
,, ,, *rufifrons,* Ibid. De Region. Marin., p. 79.
,, *Cephalothrix bioculata,* Ibid. Op. cit., p. 79.
1846. *Borlasia ? filiformis,* Johnston. Ann. Nat. Hist., vol. xvi, p. 434, pl. 15, f. 1, *a*, *b*.
1850. ,, *rufifrons,* Diesing. Syst. Helm., vol. i, p. 241.
,, ,, *longa,* Ibid. Op. cit., p. 241.
,, ,, *cephalothrix,* Ibid. Op. cit., p. 241.
,, ,, *filiformis,* Ibid. Op. cit., p. 242.
,, ,, *linearis,* Diesing. Syst. Helm., vol. i, p. 242.
,, *Cephalothrix Œrstedii,* Ibid. Op. cit., p. 246.
1853. *Gordius gracilis,* Dalyell. Pow. Creat., vol. ii, p. 74, pl. 9, f. 8—11.
1859. ,, ,, Leuckart. Archiv f. Naturges., ii, p. 187.
1861. *Cephalothrix lineata,* Claparède. Recher. Anat. sur les Ann., Turb., &c., p. 82.
1862. *Borlasia longa,* Diesing. Revis. der Turbell., p. 249.
,, ,, *rufifrons,* Ibid. Op. cit., p. 249.
,, ,, *cephalothrix,* Ibid. Op. cit., p. 250.
,, ,, *filiformis,* Ibid. Op. cit., p. 250.
,, ,, *linearis,* Ibid. Op. cit., p. 250.
,, *Cephalothrix Œrstedii,* Ibid. Op. cit., p. 254.
,, *Meckelia cæca,* Ibid. Op. cit., p. 286.
,, *Cephalothrix ocellata,* Keferstein. Zeitsch. f. wiss. Zool., Bd. xii, p. 63, taf. 6, f. 11—16.
,, ,, *longissima,* Ibid. Op. cit., p. 65, taf. 6, f. 6—10.
1863. *Borlasia linearis,* Diesing. Nachträge zur Revis. der Turbell., p. 5.
,, ,, *? longissima,* Ibid. Op. cit., p. 6.
,, *Ommatoplea ocellata,* Ibid. Op. cit., p. 7.
,, *Gordius gracilis,* Ibid. Op. cit., p. 15.
1865. *Astemma rufifrons,* Johnston. Catalogue Brit. Mus., pp. 19 and 288.
,, ,, *filiformis,* Ibid. Op. cit., p. 19.
1866. ,, *rufifrons,* Lankester. Ann. Nat. Hist., 3rd ser., vol. xvii, p. 388.
,, ,, *filiformis,* Ibid. Op. cit., p. 388.
,, *Cephalothrix lineatus,* Ibid. Op. cit., p. 388 (?)
1867. *Astemma rufifrons,* Parfitt. Catalogue Nat. Hist. Devon., Annelids, p. 5.
,, *Cephalothrix filiformis,* McIntosh. Rept. Brit. Assoc., 1867, Trans. Sect., p. 92.
1868. ,, ,, Ibid. Ann. Nat. Hist., 4th ser., vol. ii, p. 293.
1869. ,, ,, Ibid. Trans. Roy. Soc. Edinb., vol. xxv, pt. ii, p. 376 et seq.

Habitat.—Under muddy stones between tide-marks, often in great numbers, and on oysters and other shells and ascidians in the laminarian region. Ranges from Shetland to the Channel Islands.

Body.—About three or four inches long, flattened, tapering towards the snout, and much more towards the tail; most variable in appearance, now stretched to a mere thread, and again shortened to a worm of some volume, or thrown into alternate dilatations and contractions. It is marked along the centre by the pale streak of the proboscidian sheath.

Colour.—Variable. Sometimes the animal is of a pale cream-colour throughout, with no special pigmentary accumulation. A patch of yellowish pigment occurs in other cases on the snout, and the œsophageal region is yellowish; or the yellowish, orange or reddish pigment is increased towards the tip of the snout, and the œsophageal region is reddish-orange. The succeeding part is also faintly tinged in those most deeply coloured, the rest of the animal being of the usual dull whitish or skin colour, and more opaque than the former. In a female specimen laden with ova, sent from the St. Andrews rocks in April, the entire digestive cavity was of a fine dark green hue (Plate IV, fig. 5), a condition probably due to the absorption of colouring matter from the food, as specimens kept in vessels beside the ova of *Phyllodoce maculata*, Johnst., become similarly tinged towards the posterior part of the digestive tract.

Head.—Rounded, slightly tapered to a blunt point, not distinguished from the rest of the body; without eye-specks, and devoid of furrows or fissures. The mouth forms a conspicuous slit a little behind the commencement of the œsophagus, and the pouting lips would seem to be occasionally used as a kind of sucker, since a jerk occurs on raising the body from this point.

C. linearis is easily kept in confinement, moving about actively, or reclining at ease along the vessel as a slender thread. It is fond of associating with fellows of the same or a similar species, forming a tangled bunch or grouped as a radiating series of living filaments. In progression the mobile snout is used as an exploratory organ, being thrust hither and thither with ceaseless energy under a glass cover, and pushing aside its own yielding body in any direction. The latter is also frequently drawn through a loop of mucus like a thread of coherent yet fluid substance, which becomes thickened or attenuated by each successive contractile wave; and it is sometimes bent in a peculiar manner from twists round loops of mucus or the bodies of others. The skin is strongly acid to test-paper.

The ova and spermatozoa are ripe from January to June.

I have taken the *Planaria linearis* of Jens Rathke to be the present species. It was noticed by Col. Montagu and afterwards by Dr. Johnston in Britain. The *Lineus spiralis* of the former (MS.) is probably a variety to which the description exactly applies, with the exception of the "red spiral intestine." The proboscis may occasionally be tinted. The presence of pigment- or eye-specks does not seem to be of sufficient weight to separate Œrsted's *C. bioculata* and *C. cæca*, if, indeed, the former is to be included in this genus at all. The *Astemma rufifrons* of the same author is only a variety of the present species with a greater development of pigment in the snout. The woodcut (op. cit., fig. 13), however, very much resembles a compressed anterior region of *Lineus bilineatus* viewed as a transparent object. It is somewhat doubtful if his *Astemma longum* ('Kroyer's Naturhist. Tidskrift') is a *Cephalothrix*, though he places it next *A. rufifrons*. Sir J. Dalyell was the first to notice the development of this species, which he saw producing a rope of spawn in June. He correctly describes the young as having two eyes. The *Polia filum* of De Quatrefages has much resemblance to *C. linearis;* indeed, his remarks can only apply to this form or to *Nemertes carcinophila*, and the probability is in favour of the former, though he had omitted to notice the mouth. The enlarged drawing of the ganglia given by this author still further indicates the connection. This arrangement is never seen in an example of the Enopla. The *C. lineata* (Œrst.) which M. Claparède found at Skye is evidently this common species. There is also nothing in the descriptions and figures of Prof. Keferstein's *C. ocellata* and *C. longissima* to distinguish them from each other or from this form. The presence of dark pigment-specks is of no greater value specifically than the anterior red pigment in the British examples. There is considerable variation, but no character of sufficient importance to merit specific distinction. The form of the papillæ of the proboscis (which are stated to be hook-shaped) and other minute points in the author's descriptions require confirmation.

EXPLANATION OF THE LETTERS USED IN THE PLATES.

The following letters have been employed both in the Enopla and Anopla to designate similar structures :—

a. Proboscis.
f. Superior ganglionic commissure.
g. Inferior do. do.
j. Œsophageal region.
j′. Digestive canal proper.
k. General stroma of the snout.
m. Cephalic sac.
m′. Duct of do.
n. Great lateral nerve.
o. Proboscidian sheath.
ov. Ovaries, ova, or their indications.
p. Dorsal blood-vessel.
r. Lateral do.
w. Mouth.
z. Anus.
ψ. Muscular ribbon of proboscis.

Letters confined to the Enopla.

ac. Reflection of the proboscis in front of the ganglia.
b. Epidermis.
ab. Channel in the snout for the proboscis.
c. Cutis.
d. Circular muscular coat.
e. Longitudinal do.
h. Superior lobe of the ganglion.
i. Inferior do. do.
l. Cephalic blood-vessel.
q. Anastomotic do.
A. First region of the proboscis.
B. Second do. do.
C. Third do. do.

ϐ. Globule in marginal stylet-sac.
β. Stylets in do. do.
δ. Duct of do. do.
ε. Muscular chamber behind the floor of the anterior region of the proboscis.
η. Floor of the anterior chamber of the proboscis.
θ. Muscular investment of the granular basal apparatus.
λ. Granular basal apparatus.
μ. Ejaculatory duct.
μ'. Aperture of do. into chamber ε.
ν. Marginal stylet-sacs.
π. External granular glands.
ς. Reservoir.
σ. Glands of do.
τ. Spiral muscular fibres of the walls of the reservoir.
το. Longitudinal do. do.
φ. Duct of communication with the posterior chamber.
χ. Wall of the posterior chamber.

Letters used in describing the anatomy of the Anopla.

ao. Tube for the proboscis in the snout.
b. Cephalic fissures.
c. Ciliated epidermis.
d. External layer of cutis.
d'. Basement-layer.
d''. Pigment-layer in *Lineus gesserensis*.
e. External (longitudinal) muscular layer.
e'. Circular muscular layer.
e''. Inner (longitudinal) do. do.
h. Ganglia.
h'. Superior lobe of the ganglion.
h''. Inferior do. do.
s. Vascular lacunæ behind the ganglia.
u. Vascular meshes around the œsophageal region.
v. Larger vascular space at each side of the sheath for the proboscis in front.
y. Constriction between the œsophageal and succeeding alimentary regions.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

APPENDIX.

The delay which has taken place in the preparation of the coloured plates has enabled me to make a few remarks on certain recent papers bearing on the subject. Several of these are by A. F. Marion, who has already (p. 40) been alluded to as the discoverer of an hermaphrodite Nemertean, which he found, with developed generative organs, in the month of March in the Mediterranean.[1]

In a communication entitled 'Histologie du Système nerveux des Nemertes'[2] the author describes the lateral nerve-trunk as enveloped in a fine membrane, and gives an interesting account of the fibres after they have entered the ganglia. He mentions that the nerve-cells in the latter are chiefly elliptical and apolar, though multipolar are also present. He further notes that in certain forms a pulpy granular mass occurs between the external sheath and the internal fibres of the lateral nerve, probably referring to the fibro-granular matrix described on page 110, and shown in Plate XXI, fig. 6, *n'*, of the present work. In these forms, moreover, the cephalic ganglia are composed of the same pulpy mass, without a trace of cells.

Another French author, M. Léon Vaillant,[3] next advances certain remarkable opinions concerning contested points in the Nemerteans. He revives the idea, as he says, of Max Schultze and De Quatrefages, that the proboscis is the digestive organ. The works of the latter author have already been fully gone into, but I am unacquainted with the paper in which the former has propounded this erroneous idea; indeed, the contrary opinion has been taken in the review of his labours (see pp. 28, 29, &c.). His assertion that the marginal stylet-sacs furnish the stylet for the central apparatus through the ducts of the former organs has already been disposed of (pp. 57 and 67). His remarks that the posterior chamber of the proboscis has an aperture leading into "the general chamber of the body" (the proboscidian sheath being unknown), and that *Valencinia longirostris* (one of the Anopla) takes nourishment by the proboscidian aperture, scarcely require refutation.

A. F. Marion published an important article on the subject in his recent 'Recherches sur les Animaux inférieurs du golfe de Marseille,'[4] which, indeed, mainly consist of an account of an hermaphrodite Nemertean named *Borlasia Kefersteinii*, already alluded to in the "Zoography" (p. 40). The form was dredged by the author at the above-mentioned locality amongst the roots of sea-weeds, and, in conjunction with three other species of similar organization, its examina-

[1] 'Comptes Rendus,' tom. 69, 1869.

[2] Ibid., tom. 68, 1869, p. 1474.

[3] 'La Revue scientifique de la France et de l'Étranger,' &c., 2e série, 21st Sept., 1872. I am much obliged to Mr. Waterhouse, of the Zoological Department, British Museum, for a perusal of this note.

[4] 'Ann. des. sc. nat.,' v[e] sér., tome xvii, Nos. 3 & 4, 1st March, 1873.

tion afforded, he says, an opportunity of giving a very complete description. He follows Prof. Keferstein in his classification, and therefore the observations on this head in the "Zoography" are equally applicable here. He is also rather behind date in his remarks on the value of the stylet-region in the discrimination of species.

In what he calls the granular coat of the skin he found small brilliant bodies, sometimes in the form of prisms, sometimes in the form of buckles. This peculiar condition has not been observed in the British Nemerteans. Only longitudinal muscular fibres were present in his species, but he does not say that he made any transverse sections. In consonance with the structure of the Enopla, to which the form belongs, there ought to be external circular as well as internal longitudinal fibres. I cannot agree with his proposition that naturalists generally consider the proboscis an organ of offence and defence, for observations on the living animal, and the anatomy and physiology of the organ in both Enopla and Anopla, render this view quite theoretical. He is safe, however, in objecting to the interpretation of his countryman, M. Léon Vaillant, previously narrated.

A vital discrepancy is the affirmation that the mouth in his species (one of the Enopla) opens behind the ganglia, because in every example (British and foreign) of this group seen by me the position of the oral orifice is quite in front of the ganglia and ganglionic commissures, and thus, very properly, forms one of the most important distinctions between them and the Anopla, in which (latter) the mouth invariably opens behind the ganglia. As an accompaniment to this erroneous view the author has quite overlooked the characteristic œsophagus, which forms a longitudinally plaited ciliated sac (essentially differing in appearance from the rest of the digestive chamber) behind the ganglia. The oral slit shown in his figure might pass for one of the longitudinal rugæ of the organ. It is by no means easy to arrive at an accurate knowledge of the anatomy of these animals, and hence the greatest care and patience are necessary.

He further observes that the proboscis is fixed to the wall of the "general cavity of the body," a position it does not occupy, since it is enclosed in its special sheath of two coats, and to the inner surface of which the terminal ribands are duly fixed. M. Marion's interpretation implies a total want of this sheath, which, I am sure, a single transverse section would at once render apparent. He next narrates that the anterior region of the proboscis is covered with papillæ, but he would have been more exact if he had mentioned that these organs are internal, for on glancing at his figure (Pl. 17, fig. 3, op. cit.) it is difficult to say whether they are wholly internal or also common to the external surface. To have got the figure the organ must have been turned inside out at its anterior part. The basal apparatus of the central stylet is described as brownish. It is only so by transmitted light—from the dense mass of white granules. The terminations of the ducts of the marginal stylet-sacs have never, in any form observed by us, been close to the aperture for the central stylet in the floor of the anterior chamber, but at some distance therefrom. The statement, also, that below the stylet-sacs the fibrous tissue is furnished with fine pigment-granules is not sufficiently comprehensive, for no mention is made of the regularly arranged circlet of granular glands (π in our figures), neither is any help on this point obtainable from the plate.

Another discrepancy is the arrangement of the duct from the reservoir (his *poche de réserve du liquide venimeux*), which canal he describes and figures as extending forward to open into the floor of the anterior chamber near the point of the central stylet. If the author had watched an organ under careful pressure he would have seen the granular gland-cells from the posterior chamber (his *région glandulaire de la trompe*) roll forward into the reservoir, and find exit singly into the muscular cavity (ε in our figures) behind the floor of the anterior chamber, and which the author actually represents without comment. Moreover, that afterwards they passed into the cavity of the anterior chamber by the aperture for the central stylet. With regard to his discussion concerning the venomous nature of the fluid in the reservoir, I would not, for my part, say that it is poisonous. It is clear, from the minute anatomy of the organ, that the fluid cannot enter a wound inflicted by the stylet until the latter is withdrawn; and, as stated previously (p. 62), the proboscis is a somewhat precarious aggressive weapon. The jerking movements observed by the French author in the protruded proboscis are common enough in a structure so muscular and mobile, but they may be explained otherwise than on the supposition of attacking prey. My experience of the organs in the Anopla, also, does not coincide with his observation that they subserve the same function, viz. the secretion of poison. Neither has anything been observed to support the view that other marine animals, such as Crustacea, manifest great repugnance to the Nemerteans, nor is it probable that nature furnished the latter with cilia (in lieu of urticating organs) to warn their fellows of their deadly approach.

The author admits that he has only imperfectly examined the organs of circulation, a fact apparent from his remark (and figure) that a central dorsal vessel springs from the middle of the cephalic arch at the tip of the snout. As formerly shown (p. 79), the dorsal vessel arises from the two lateral—by the anastomotic—behind the ganglia.

He indicates the discovery of a curious species, having small clear processes like buckles in its cutis, and analogous to the bodies in the muscles of Echinoderms; hence he calls it *Borlasia echinoderma*. The basal apparatus of the central stylet in this species is truncate posteriorly, as in *Prosorhochmus Claparedii*. Some interesting details are given of its nervous system, amongst others the curious fact that the first eleven pairs of lateral nerves (from the great lateral trunks) go to a series of eyes furnished with refracting globules. The anterior eyes are supplied, as usual, by branches from the ganglia.

The paper concludes with an account of the reproductive organs of *Borlasia Kefersteinii*. The statement that on attaining full development the ova and spermatozoa burst their envelopes and escape into the "general cavity of the body" is not in accordance with our observations. The apertures along the sides, which the author failed to see in this small species, render such a supposition unnecessary, though, of course, not impossible. His asking if, like Keferstein, we are to consider the cephalic sacs and "fossettes céphaliques" the channels whereby the reproductive products are expelled, is not in keeping with a thorough knowledge of the subject. In the viviparous *Prosorhochmus Claparedii* even the largely developed young are confined to certain definite spaces in the body of the parent, but their actual mode of exit in this species is still involved in obscurity. It is to be remembered in connection with the subject that in *Nemertes carcinophila*, also occasionally a viviparous species, the sexes are separate.

The author's allusion to the literature of the subject is meagre, and though several of his views are nearly identical with, or modifications of, those promulgated long ago by his distinguished countryman, M. de Quatrefages, he does not even mention his name. The plate of figures accompanying the paper is considerably behind date in accuracy.

An important memoir (an abstract of which has only been published) in connection with the homologies of the subject is that 'On the Anatomy and Histology of the Land-Planarians of

Ceylon,'[1] by Mr. H. N. Moseley, now one of the naturalists in the "Challenger" expedition. The author specially examined the genera *Bipalium* and *Rhynchodemus;* and since my observations on the former had been made some years ago, and printed off several months before the above paper reached the Royal Society, a comparison of the results will be interesting. He agrees with me in affirming that the skin closely conforms to the Planarian type. The flask-shaped cells filled with "stäbchenförmigen Körpern" below the cutis he thinks homologous with the "nail-like bodies of the Nemertines;" but if he means by the latter expression the proboscidian stylets, the homology is not very apparent, any more than the conjecture concerning their possible alliance with the bristles of the Annelida. He makes the curious statement that "it is commonly said that whilst in all other Vermes the external muscular layer is circular, and the longitudinal internal, in Turbellarians the reverse is the case;" but he might have observed, in a paper on the "Anatomy of the Nemerteans,"[2] that considerable differences exist in the arrangement of the muscular coats of the great groups—for example, between the Enopla and Anopla, the external muscular layer in the former being circular, while in the latter it is longitudinal. With regard to the nature of the pale areas described on p. 143, and which Mr. Moseley calls primitive vascular trunks, I was in doubt after the examination of my specimen, though I could not see anything nervous about them. If such be a water-vascular system it is totally different from the circulatory trunks in the Nemerteans, which I hold to be the blood-vessels of the animals. Some interesting theoretical remarks are appended to the communication.

The latest publication pertaining to the subject is by M. E. Zeller,[3] on the "Structure of the Proboscis of *Borlasia Kefersteinii,*" Marion, the author having worked under the direction of the latter. He is of opinion that the species must be united with that parasitic on the branchial tissue of *Phallusia mamillata.* It is therefore probably a similar—if not the same—form as Delle Chiaje or Leuckart and Pagenstecher long ago described (see p. 2, &c.). Unfortunately the author is not more precise than M. Marion with regard to the anatomical position of the proboscis, which, he states, is attached to the "walls of the general cavity." The complex structure of the anterior region is not precisely detailed, and the same remark is applicable, as in the case of M. Marion, to his definition of the granular basal apparatus of the central stylet, which is held to be brownish. He, however, has evidently more acquaintance than his colleague with the muscular cavity (ε in our figures) behind the floor of the anterior chamber, though his description is somewhat obscure. Three marginal stylet-sacs are mentioned as characteristic of the species. The dark layer above the styliferous apparatus would have been whitish by reflected light. He agrees with M. Marion in calling the reservoir a poison-sac, but is not definite enough in his account of the termination of its duct (which opens into the chamber ε). The physiological observations on the ejection of the proboscis have been anticipated.

1 'Proceed. Roy. Soc.,' vol. xxi, No. 142, received January, 1873; also in 'Annals Nat. Hist.,' vol. xi, 4th ser., No. 64, April, 1873, &c.

2 'Trans. Roy. Soc. Edinb.,' vol. xxv, p. 305, 1869.

3 'Ann. Nat. Hist.,' vol. ii, 4th series, No. 65, p. 398, May, 1873 (from the 'Comptes Rendus,' April 14th, 1873).

ERRATUM.

Delete the first synonym (date 1776) on p. 156, and the allusions thereto on pp. 10 and 158.

PLATE XI.

Fig.

1. Transverse section of the cephalic ganglia of *Amphiporus lactifloreus*, in the line of the commissures, the superior of which, from the flattening of the preparation, is shown very plainly. *a*, proboscis; *d*, circular muscular fibres of the body-wall; *k*, muscular and cellular stroma of the region. × 90 diam.

2. Section through the body of the same animal some distance behind the ganglia. The sheath for the proboscis now separates the latter from the œsophagus, which has attained considerable size. The lateral nerve-trunks have nearly reached their proper position, viz. to the inner side of the internal muscular layer of the body-wall; *s*, granular masses (from the digestive cavity proper) at the sides of the œsophagus. × 55 diam.

3. Section of the same specimen behind the foregoing and towards the posterior end of the œsophageal apparatus. *u*, ova pressed forward by the contraction of the textures.

4. Transverse section of the anterior region of the proboscis of *Amphiporus pulcher*. *a*, central cavity; *b*, the papillary glandular layer; *c*, internal circular muscular coat; *d*, inner longitudinal layer; *e*, reticulated or beaded layer; *f*, external longitudinal muscular layer; *g*, external (elastic) layer; *h*, basement-layer. × 55 diam.

5. Transverse section of the stylet-region of the proboscis of *A. lactifloreus*, in the line of the marginal sacs. The circumference of the preparation is somewhat distorted from pressure. × 350 diam.

6. Transverse section of the same region in another specimen, in which the knife has pressed aside the basal apparatus of the central stylet (λ), and in which the ejaculatory duct (μ) has been cut obliquely. In this and the preceding preparations the peculiar arrangement of the muscular fibres of the region is represented. × 210 diam.

7. Longitudinal section of the anterior region of the proboscis of *Amphiporus lactifloreus*. × 90 diam.

8. Longitudinal section of the same region of the proboscis. × 350 diam.

9. Transverse section of the same part of the proboscis. *e′*, the ends of the longitudinal bands of the reticulated layer, which have assumed a finely granular aspect in the preparation. × 350 diam.

10. Glandular papillæ in the anterior region of the proboscis of *A. lactifloreus*, seen in the ordinary condition of the organ under pressure. × 210 diam.

11. Central stylet and basal apparatus of *Nemertes Neesii*. × 350 diam.

12. Central stylet of *N. Neesii*. × 700 diam.

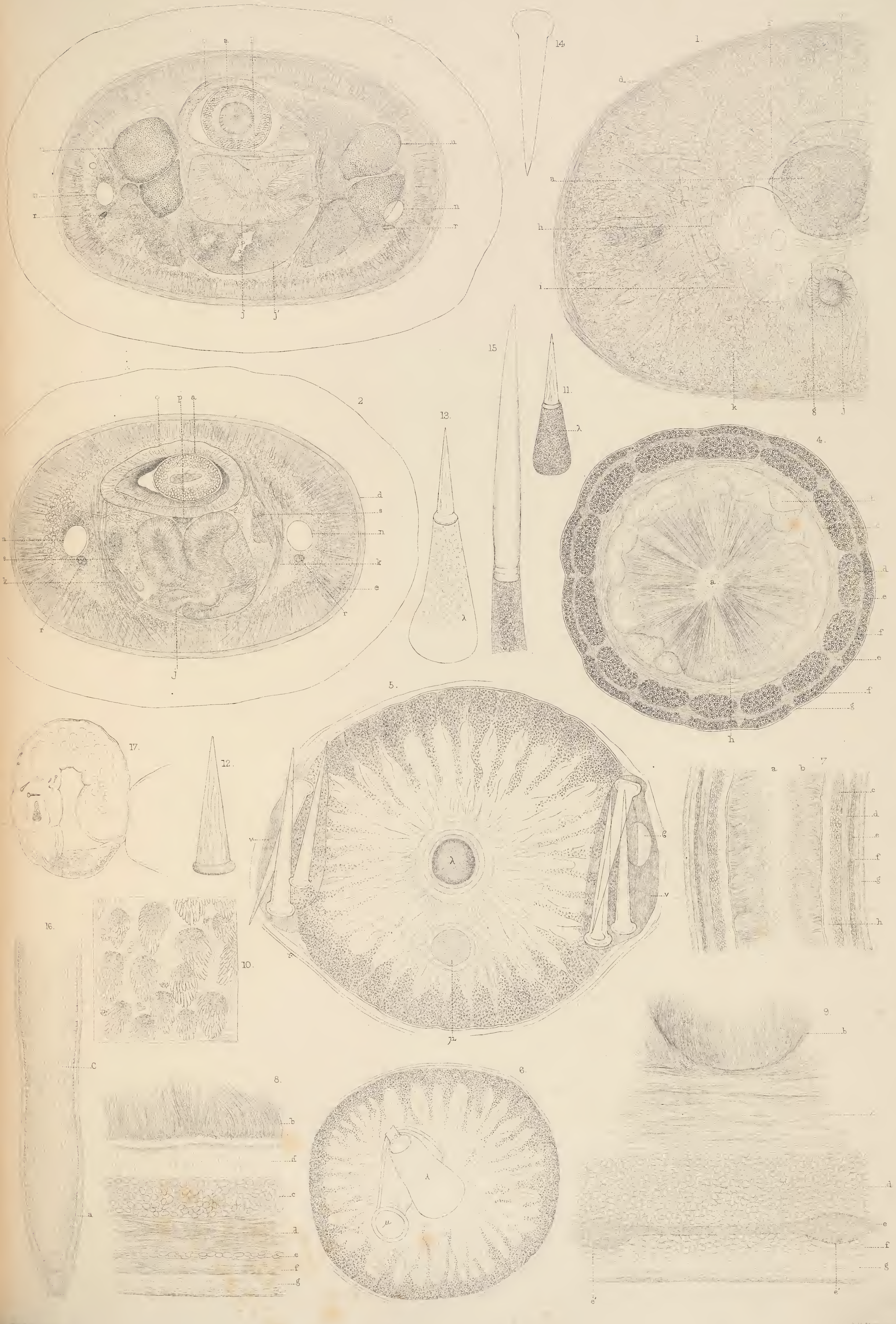
13. Developing or recently repaired central stylet-apparatus of *Tetrastemma candida*. × 700 diam.

14. Stylet from a marginal sac of the same animal. × 700 diam.

15. Central stylet and a portion of the basal apparatus in a large *Nemertes gracilis*. × 350 diam.

16. Extremity of the posterior region (c) of the proboscis of *A. lactifloreus* distended with fluid. *a*, a group of the peculiar moving granules. × 90 diam.

17. Posterior end of a young example of *Tetrastemma dorsalis*, showing the usual hernia of the proboscis under pressure. × 350 diam.



Mintern Bros. imp.

PLATE XII.

Fig.

1. Structure of the stylet-region in a large *Amphiporus lactifloreus*. The specimen had two marginal sacs on one side. × 350 diam.

2. Structure of the stylet- and reservoir-regions in the same form. Considerably magnified.

3. Abnormal stylet-region in the same species. *a*, perfect stylet-sac of the left side; *b*, shriveled sac of the right side. × 210 diam.

4. Termination of the posterior chamber of the proboscis (c) of *A. lactifloreus*, with muscular ribands. × 210 diam.

5. The central (*a*) and marginal stylets (*b*) from a young *A. lactifloreus*, on the first appearance of the former. × 700 diam.

6. Structure of the stylet-region of the proboscis of *Amphiporus pulcher*. × 90 diam.

7. Central stylet-apparatus of the same species. *a*, central stylet; *b*, reserve-stylet *in sitú*. × 210 diam.

8. Structure of the stylet-region in *Tetrastemma melanocephala*. × 90 diam.

9. Structure of the stylet-region in *Tetrastemma flavida*, with the reservoir somewhat contracted. × 210 diam.

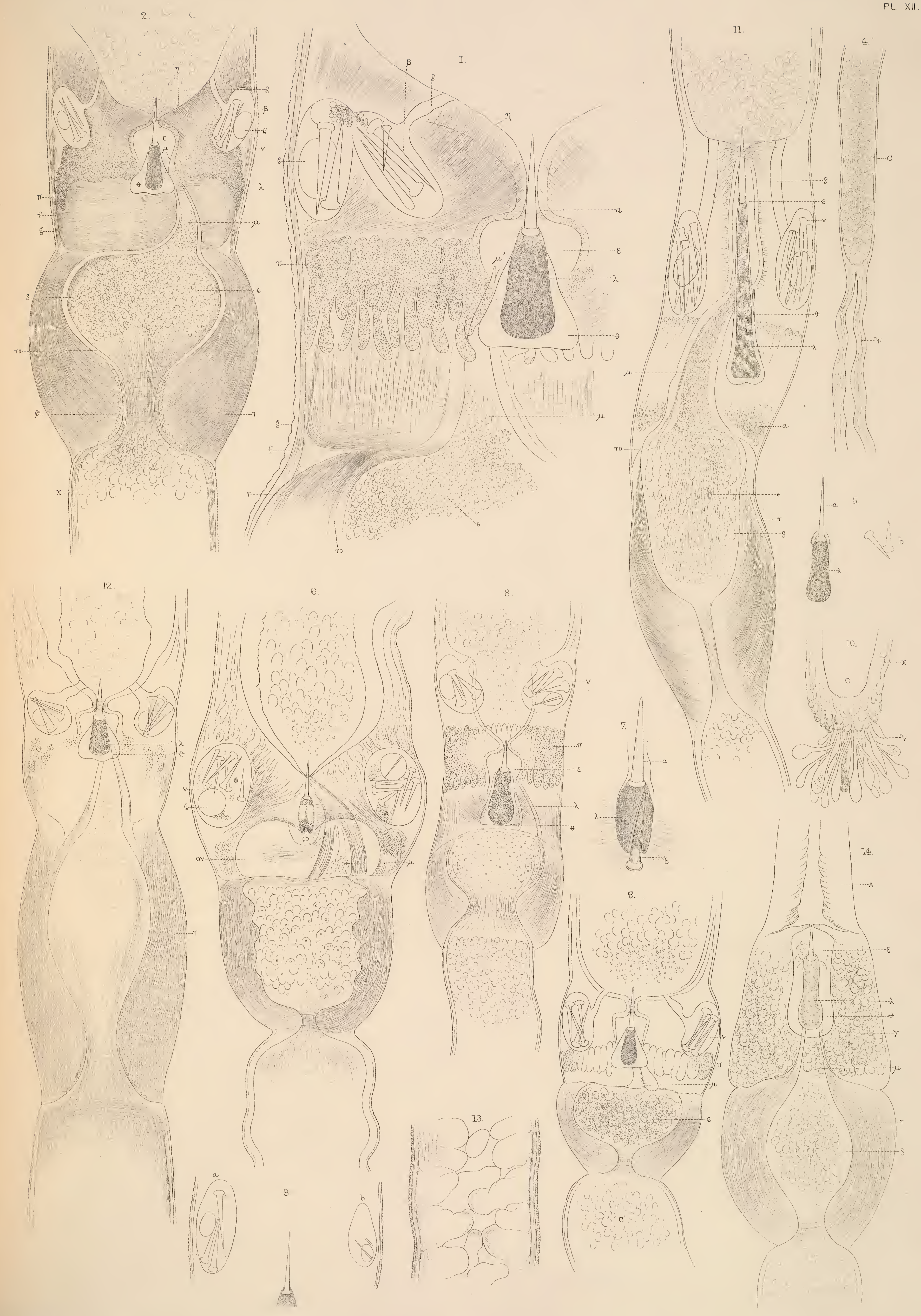
10. Extremity of the posterior chamber of the proboscis of *Tetrastemma dorsalis*, apparently after rupture of the muscular ribands from the sheath of the organ. × 350 diam.

11. Structure of the stylet-region of the proboscis in *Nemertes gracilis*. × 210 diam.

12. Structure of the stylet-region of the proboscis of *Nemertes Neesii*. × 210 diam.

13. Portion of the posterior chamber of the proboscis of the same species, showing the characteristic plaits of the mucous surface. × 90 diam.

14. Structure of the stylet-region of the proboscis of *Nemertes carcinophila*. × 700 diam.



W.C.M. ad nat. del.

Mintern Bros. imp.

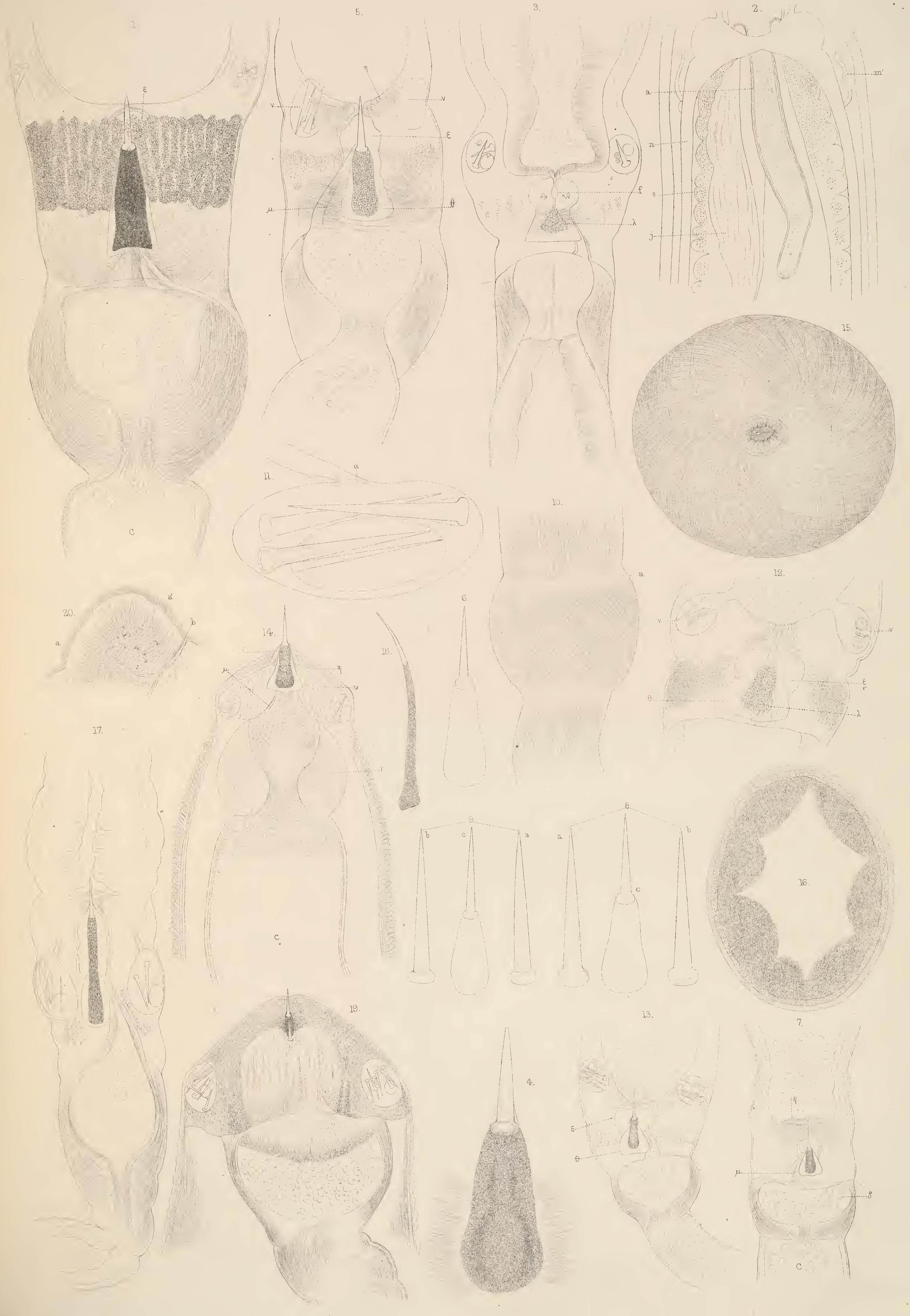
G.H. Ford sc.

PLATE XIII.

Fig.

1. Structure of the stylet-region of the proboscis of *Prosorhochmus Claparedii*. Degeneration of the marginal sacs has ensued from long confinement. × 90 diam.
2. Aspect of the developing proboscis (*a*) of *Tetrastemma melanocephala*, about the fifth day after the removal of the original organ. × 55 diam.
3. Structure of the stylet-region of a developing proboscis of the same species. *f*, canal, which by-and-by is occupied by the central stylet. The organ is contracted. × 350 diam.
4. Central stylet and basal apparatus with radiating fibres in *Tetrastemma vermicula*. × 350 diam.
5. Stylet-region of the proboscis of *T. candida*, with the ejaculatory duct pressed to the left side. The marginal stylet-sacs are out of focus. × 210 diam.
6. Central stylet and basal apparatus of a small specimen of the same species. × 420 diam.
7. Structure of the stylet-region in *Tetrastemma dorsalis*, somewhat contracted, with the floor of the anterior chamber pouted forward, and the reservoir shortened in its antero-posterior diameter. × 210 diam.
8. Stylets of the same species. *a*, central stylet; *b*, stylet from a marginal sac. × 700 diam. *c*, central stylet and its basal granular apparatus. × 420 diam.
9. Stylets of *Tetrastemma flavida*. *a*, central stylet; *b*, stylet from a marginal sac. × 700 diam. *c*, central stylet and its basal apparatus. × 420 diam.
10. Superficial structure of the stylet- and reservoir-regions of *A. lactifloreus*. Considerably magnified.
11. Isolated marginal stylet-sac of the same species. *a*, fibres which probably act as constrictors of the aperture of the duct. The laminated arrangement of the calcareous layers of the stylets is indicated in this figure. × 350 diam.
12. Stylet-region of the proboscis of a young animal of the same species, illustrating the first appearance of the stylets and the development of the parts. The organ is drawn as it bulged from a wound in the body-wall of the specimen. × 700 diam.
13. Stylet-region of a young *A. lactifloreus*, some weeks older than that represented in the previous figure. × 350 diam.
14. Proboscis of an adult of the same species, gently but completely extruded under chloroform, so as to render the central stylet prominent. × 55 diam.
15. Transverse section of the contracted reservoir-region of the proboscis of the same species, showing the complex spiral arrangement of the fibres. The organ is cut towards its posterior end. × 55 diam.
16. Transverse section of the posterior chamber of the proboscis in a large example of the same species. × 90 diam.
17. Structure of the stylet-region in a developing proboscis of *Nemertes gracilis*. × 350 diam.
18. Central stylet and its basal apparatus in the same species, turned round so as to demonstrate the curve of both. × 100 diam.
19. Proboscis of *Amphiporus pulcher* treated as in fig. 14. × 55 diam.
20. Fragment of the œsophageal region of the digestive tract from a living *A. lactifloreus*. *a*, inner edge of ciliated fold; *b*, sulcus between two folds. × 350 diam.

PL. XIII.

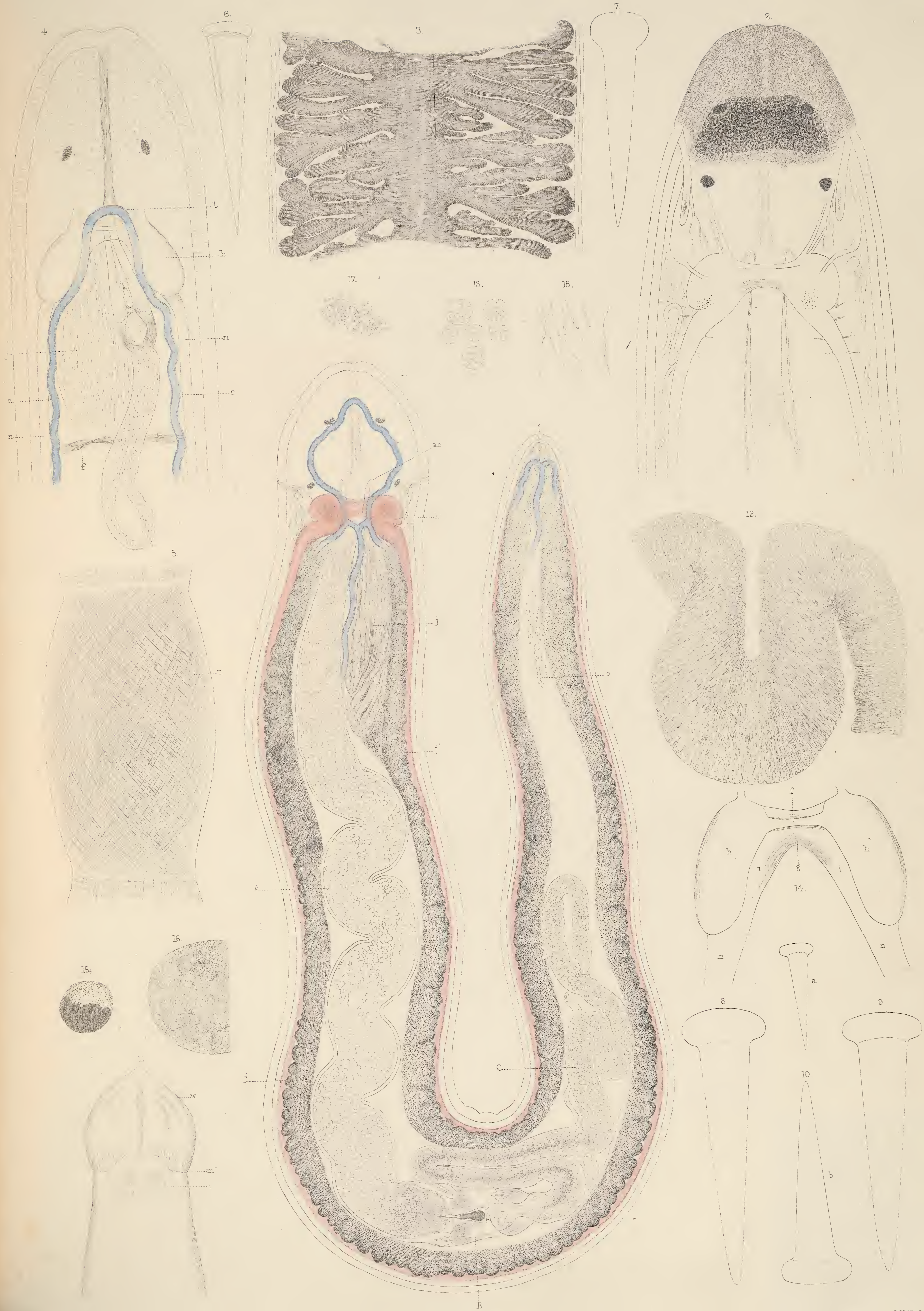


G.H. Ford sc.

PLATE XIV.

Fig.

1. The anatomy of *Tetrastemma candida,* chiefly with respect to the digestive and proboscidian systems. Considerably magnified. h°, abnormality of the right ganglion.
2. Structure of the head of a young *Tetrastemma melanocephala,* showing the ganglia and the relation of the pigment-patch to the eyes. Considerably magnified.
3. Digitate or lobate arrangement of the digestive canal of *Nemertes gracilis.* × 24 diam.
4. Head and anterior portion of *Nemertes carcinophila.* *f,* powerful transverse fibres which retain the posterior part of the œsophagus *in sitû.* × 180 diam.
5. Superficial structure of the reservoir in *Nemertes Neesii,* showing the elaborate interlacing of the fibres. × 210 diam.
6. Stylet from a marginal sac of *Tetrastemma candida* (same animal as in fig. 6, Plate XIII). × 700 diam.
7. Stylet from the central apparatus of the same specimen. × 700 diam.
8. Stylet from a marginal sac of *Tetrastemma melanocephala.* × 700 diam.
9. Stylet from the central apparatus of the same specimen. × 700 diam.
10. Marginal stylet of *Tetrastemma Robertianæ.* *a* × 350 diameters, *b* × 700 diam.
11. View of the under surface of the snout of *Amphiporus pulcher.* The mouth is indicated at *w*, the cephalic furrows and their branches at m'', and the situation of the ganglia at *i.* Enlarged under a lens.
12. Transverse section of the wall of the œsophagus of *A. lactifloreus,* after mounting in chloride of calcium. × 210 diam.
13. Compound cells from the wall of the digestive cavity of *Tetrastemma dorsalis.* × 350 diam.
14. Cephalic ganglia of *Tetrastemma flavida.* × 210 diam.
15. Eye of *Amphiporus pulcher* from a dead and slightly injured specimen. × 210 diam.
16. Portion of a sperm-sac from *Tetrastemma flavida,* exhibiting a streaky and granular aspect from the varying nature of the contents. × 350 diam.
17. Granules from a developing sperm-sac of *T. dorsalis.* × 400 diam.
18. Spermatozoa of *Amphiporus lactifloreus.* × 800 diam.



G.H. Ford sc.

PLATE XV.

Fig.

1. Transverse section somewhat behind that shown in Plate XI, fig. 1. The instrument has passed obliquely across the body so as to cut the ganglia at different distances from the front. On the right only the tip of the superior lobe remains, while the commencement of the great nerve-trunk—in full bulk—is cut beneath. × 90 diam.

2. Snout and anterior region of *A. pulcher*. *g*, *g*, glandular masses. × 55 diam.

3. Arrangement of the circulatory and nervous systems in *A. lactifloreus* (a small specimen). × about 40 diam.

4. Portion of the head of the same species considerably flattened. × 210 diam.

5. Head of *Nemertes Neesii*. × about 60 diam.

6. Nerve-cells from a cephalic ganglion of *A. lactifloreus*. × 400 diam.

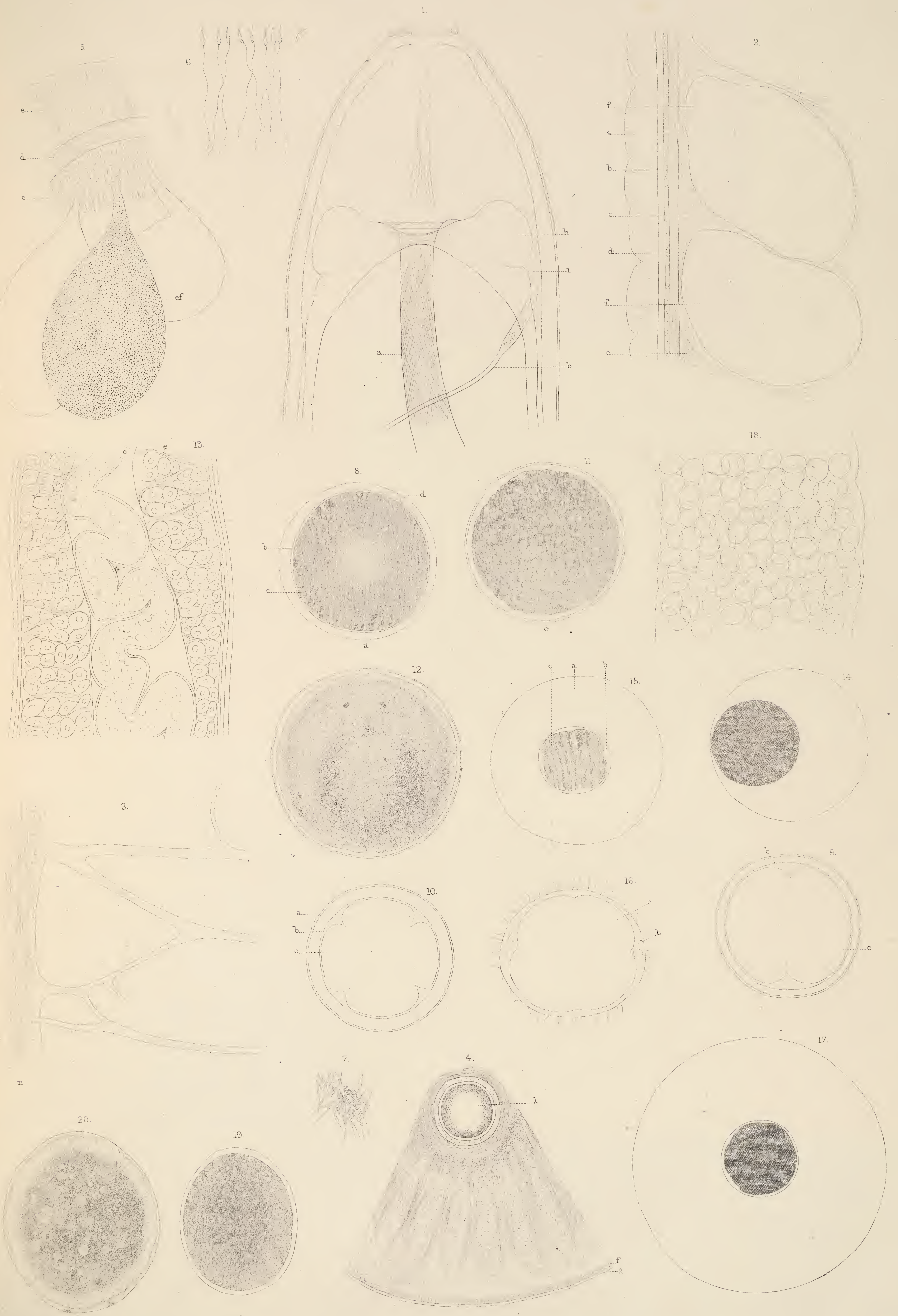

1.
o
a
h
h
d
n
e
j
2.
g
gi
gi
m
n
m'
J
3.
q
h
j
p
A
o
n
r
C
o
p
r
p
B
4.
ac
l
L
ab
a
a
a
m
h
5.
m
h
h
6.

G.H. Ford

PLATE XVI.

Fig.

1. Anterior end of *Tetrastemma dorsalis*. *a*, proboscis, whose fibres have temporarily assumed a spiral aspect from twisting. *b*, tube connected with the cephalic sac of the right side. Considerably magnified.
2. Longitudinal section of the body-wall of *A. lactifloreus*, in a somewhat shriveled condition. *f*, *f*, ovisacs from which the contents have fallen. Other letters as usual. × 90 diam.
3. Nervous plexus from the lateral trunk (*n*) in *A. pulcher*. × 210 diam.
4. Transverse section of the anterior part of the stylet-region proper, showing the divergent arrangement of the oblique fibres and the position of the longitudinal series. × 210 diam.
5. Three sperm-sacs (*ef*) with a portion of the body-wall of *A. lactifloreus*. × 90 diam.
6. Spermatozoa of *Tetrastemma vermicula*. × 1000 diam.
7. Spermatozoa of *Tetrastemma dorsalis*. × 400 diam. This drawing was made many years ago, and probably represents imperfectly developed bodies.
8. Unimpregnated ovum of *A. lactifloreus*. *a*, outer coat; *b*, inner coat; *c*, vitellus; *d*, "micropyle," or cicatrix-like arrangement. × 90 diam.
9. The same ovum some hours after impregnation. The vitellus (*c*) is now divided into two portions. × 90 diam.
10. The same ovum a few hours later. The vitellus is in four portions. × 90 diam.
11. Ovum of the same species in the mulberry-stage. × 90 diam.
12. Ovum just before the extrusion of the embryo. × 90 diam.
13. Arrangement of the ova in the ovisacs of *Tetrastemma vermicula*. *a*, proboscis; *o*, proboscidian sheath. × 24 diam.
14. Ovum of the same species. × 90 diam.
15. Ovum of *Nemertes gracilis* after impregnation. *a*, outer coat; *b*, inner coat; *c*, vitellus. × 90 diam.
16. The inner coat and vitellus of an ovum (of *N. gracilis*) at the same stage of development, with the relations of the spermatozoa. × 210 diam.
17. Ovum of *N. Neesii*. × 55 diam.
18. Portion of the mucous sheath with the ova of *Nemertes carcinophila*. × 24 diam.
19. Ovum of the same species immediately after deposition. × 350 diam.
20. Another ovum, about the tenth day, showing the ciliated embryo revolving therein. × 350 diam.



Mintern Bros imp.

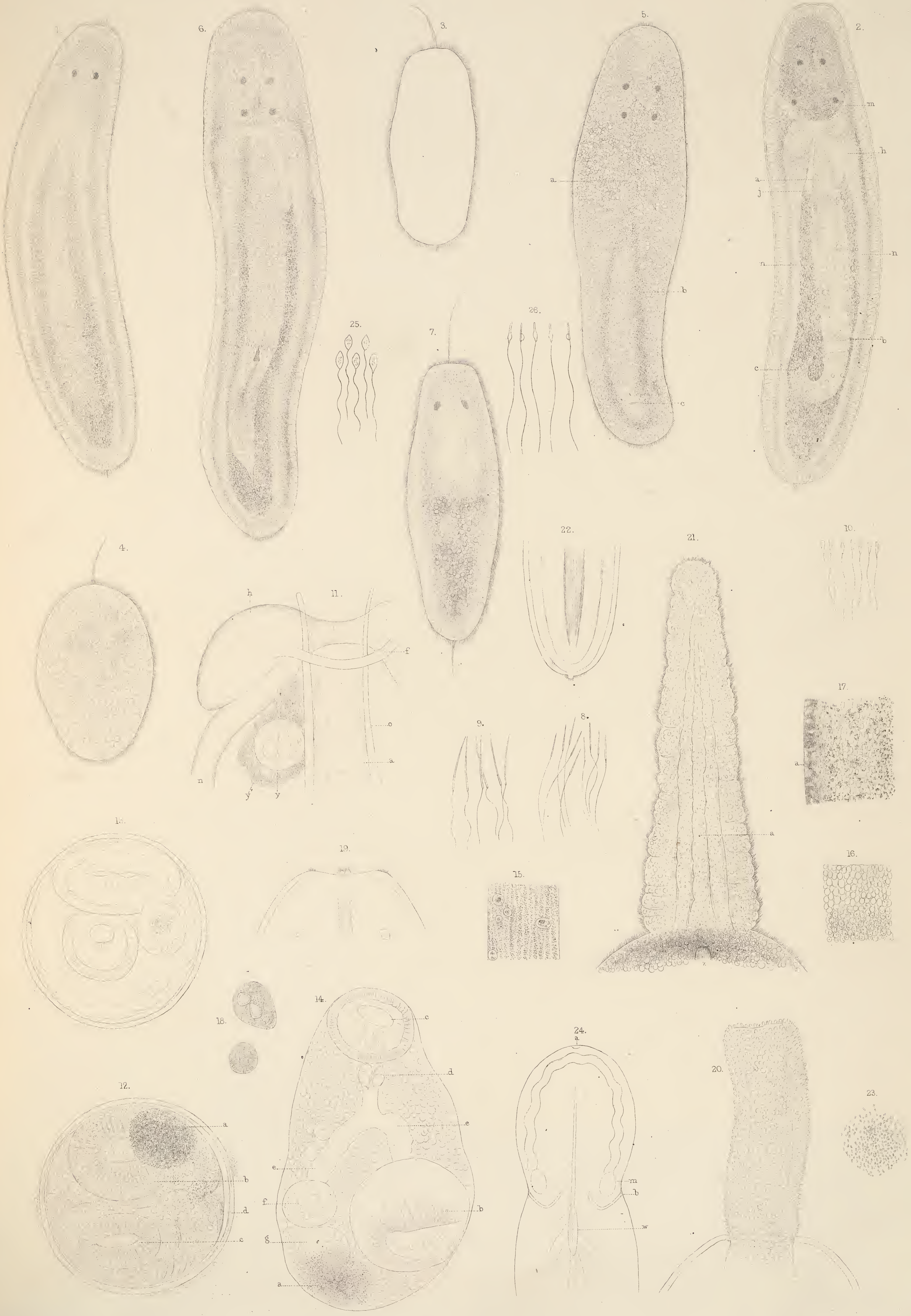
G.H. Ford sc.

PLATE XVII.

Fig.

1. A young specimen of *A. lactifloreus* on extrusion from the egg. Somewhat compressed. × 55 diam.
2. Another specimen eight days older than the preceding. *b*, stylet-region; *c*, point where the posterior chamber of the proboscis becomes lost, after curving forward. × 90 diam.
3. Outline of a young specimen of *Tetrastemma dorsalis* shortly after extrusion from the egg. × 350 diam.
4. The same compressed, so as to exhibit its cellulo-granular structure. × 350 diam.
5. Young specimen of *T. dorsalis,* about a week older than the preceding. *a*, cutaneous textures; *b*, cells and granules of the alimentary tract; *c*, stylet-region. × 210 diam.
6. A specimen eight days older than the foregoing, showing a considerable advancement in all the organs. × 210 diam.
7. A young example of *N. carcinophila* extruded from the body of the adult under pressure. It has the same appearance when originating in a free ovum. × 350 diam.
8. Spermatozoa of *Nemertes gracilis*. × 700 diam.
9. Spermatozoa of *N. carcinophila*. × 950 diam.
10. Spermatozoa of *Amphiporus pulcher*. × 700 diam.
11. Magnified view of the ganglionic region of a large *A. lactifloreus*, in which a parasitic ovum (*y*) lay imbedded in a granular lobulated mass (*y′*).
12. Parasitic ovum immediately after removal. *a*, opaque mass of cells and granules; *b*, ventral disc; *c*, oral disc; *d*, capsule, to which some shreds of the surrounding tissue are adhering. Considerably magnified.
13. The same ovum some hours afterwards, showing slight contraction of the discs.
14. Parasite extruded from the capsule. *a*, opaque cellular and granular mass; *b*, ventral disc; *c*, oral disc; *d*, œsophageal bulb; *e*, alimentary cæca; *f* and *g*, large circular granular bodies.
15. Streaked arrangement of the cutis from the dorsum of *Lineus gesserensis*. × 210 diam.
16. View of the cutis of the same species (at a pale portion) as a transparent object. × 210 diam.
17. Portion of the skin of a living *Carinella annulata*. × 350 diam.
18. Pigment-cells from the anterior dorsal region of *Lineus gesserensis*. × 350 diam.
19. Papillæ on the snout of the same species. × 210 diam.
20. Tip of the snout in the same species, with the proboscis partly extruded. × 210 diam.
21. Posterior extremity and styliform process of *Micrura fasciolata*. *a*, central cavity, containing fluid; *z*, anus. × 210 diam.
22. Posterior extremity of a young example of *L. gesserensis,* showing the anal papilla. × 210 diam.
23. Corpuscles of the extruded fluid (page 114) from *Borlasia Elizabethæ*. Highly magnified.
24. Anterior extremity of *Carinella annulata*. *a*, aperture in snout for proboscis; *b*, cephalic furrows; *c*, cephalic blood-vessel; *m*, cephalic sac; *w*, mouth. Magnified.
25. Spermatozoa of *Amphiporus bioculatus*. × 700 diam.
26. Spermatozoa of *Tetrastemma Robertianæ*. × 700 diam.

PL. XVII.



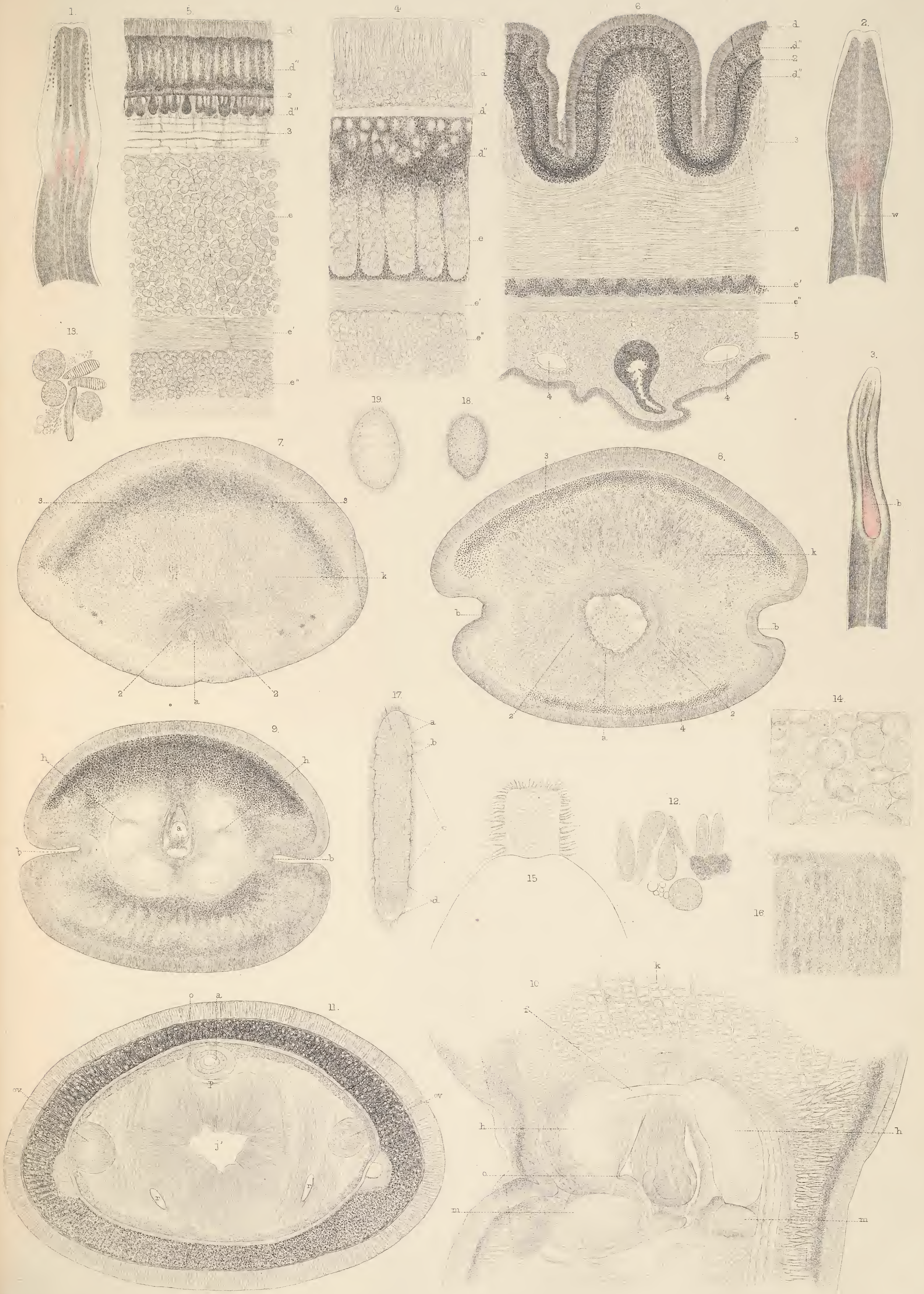
Mintern Bros. imp.

G.H. Ford sc.

PLATE XVIII.

FIG.

1. Dorsal view of the head of *Lineus marinus* after long confinement. The blanching of the cutaneous tissues renders the eyes conspicuous. Magnified under a lens.
2. Ventral view of the same specimen exhibiting the mouth (*w*). Similarly magnified.
3. Profile of the same head, showing a cephalic fissure with its reddish coloration posteriorly.
4. Transverse section of the body-wall of *Lineus gesserensis*. × 350 diam.
5. Transverse section of the body-wall of *Lineus marinus* at a somewhat narrow portion. *d*, external cuticular layer; *d''*, pigmentary layer divided into two strata by a definite black band (2); 3, curious translucent stratum cut into regular spaces. Other letters as usual. × 210 diam.
6. Longitudinal section of the same tissues. 4, 4, sections of the transverse connecting trunks between the lateral and dorsal vessels; 5, granular stroma within the inner longitudinal muscular coat, supporting the former and various other tissues. × 90 diam.
7. Transverse section just behind the tip of the snout of *L. gesserensis*. The grouping of the pigment (3) readily enables the observer to distinguish the dorsal from the ventral surface; 2, powerful series of fibres arching over the channel for the extrusion of the proboscis, and radiating into the surrounding stroma (*k*). × 55 diam.
8. Transverse section somewhat behind the preceding, and through the anterior part of the cephalic fissures. The channel for the proboscis has become more central in position. The superior pigmentary belt (3) is somewhat narrower, and an inferior (4) has now appeared. The central channel has a layer of longitudinal muscular fibres internally, and a powerful series of oblique and circular fibres (2, 2) form a very efficient exterior investment. × 55 diam.
9. Transverse section of the cephalic ganglia of a smaller specimen than the preceding. × 55 diam.
10. Horizontal section of the snout of the same species through the ganglia, exhibiting the relations of the latter and the reticulations of the cutaneous tissues in front of them. × 90 diam.
11. Transverse section of a specimen of *L. gesserensis* (after spawning) a little in front of the tip of the tail. × 90 diam.
12. Elements from the glandular papillæ of the proboscis of the same species, after their escape into the water. × 700 diam.
13. Elements from the proboscis of *Micrura fasciolata*. Similarly magnified.
14. Portion of the inner surface of the proboscis of *L. gesserensis*, showing the glandular papillæ. Slightly compressed. × 700 diam.
15. Snout of *Cephalothrix linearis* with the proboscis slightly everted, so as to exhibit the acicular papillæ. × 350 diam.
16. Fragment of the wall of the proper digestive chamber of *L gesserensis*. The cilia mark the inner surface. × 350 diam.
17. Parasitic ciliated animal from the tissues of the same species. The letters *a*, *b*, *c*, and *d* correspond with the groups of segments described in the text. × 350 diam.
18. The foregoing parasite at an earlier stage of development. × 350 diam.
19. The last-mentioned specimen subjected to slight pressure, so as to exhibit the segments. × 350 diam.



G.H. Ford sc.

PLATE XIX.

FIG.

1. Enlarged view of the anterior region of *Lineus gesserensis*, as a transparent object.

2. Anterior portion of *Lineus sanguineus*. *y*, peculiar incurvation of the wall of the alimentary canal, marking the boundary between the œsophageal and the succeeding division of the digestive apparatus. × 90 diam.

3. Anterior portion of *Lineus lacteus*. × 90 diam.

4. Portion of the middle region of *L. gesserensis*, representing the arrangement of the vessels in the living animal. Considerably enlarged.

5. Arrangement of the vessels at the posterior extremity of the same species. Similarly magnified.

6. Posterior portion of a specimen of the same species having an unusually distinct anus (probably from partial repair after injury). *a*, mass of granular and cellular débris revolving in the direction of the arrow by aid of the cilia of the digestive cavity; *b*, anus. × 210 diam.

7. Transverse section of the proboscis of *Borlasia Elizabethæ*. × 210 diam.

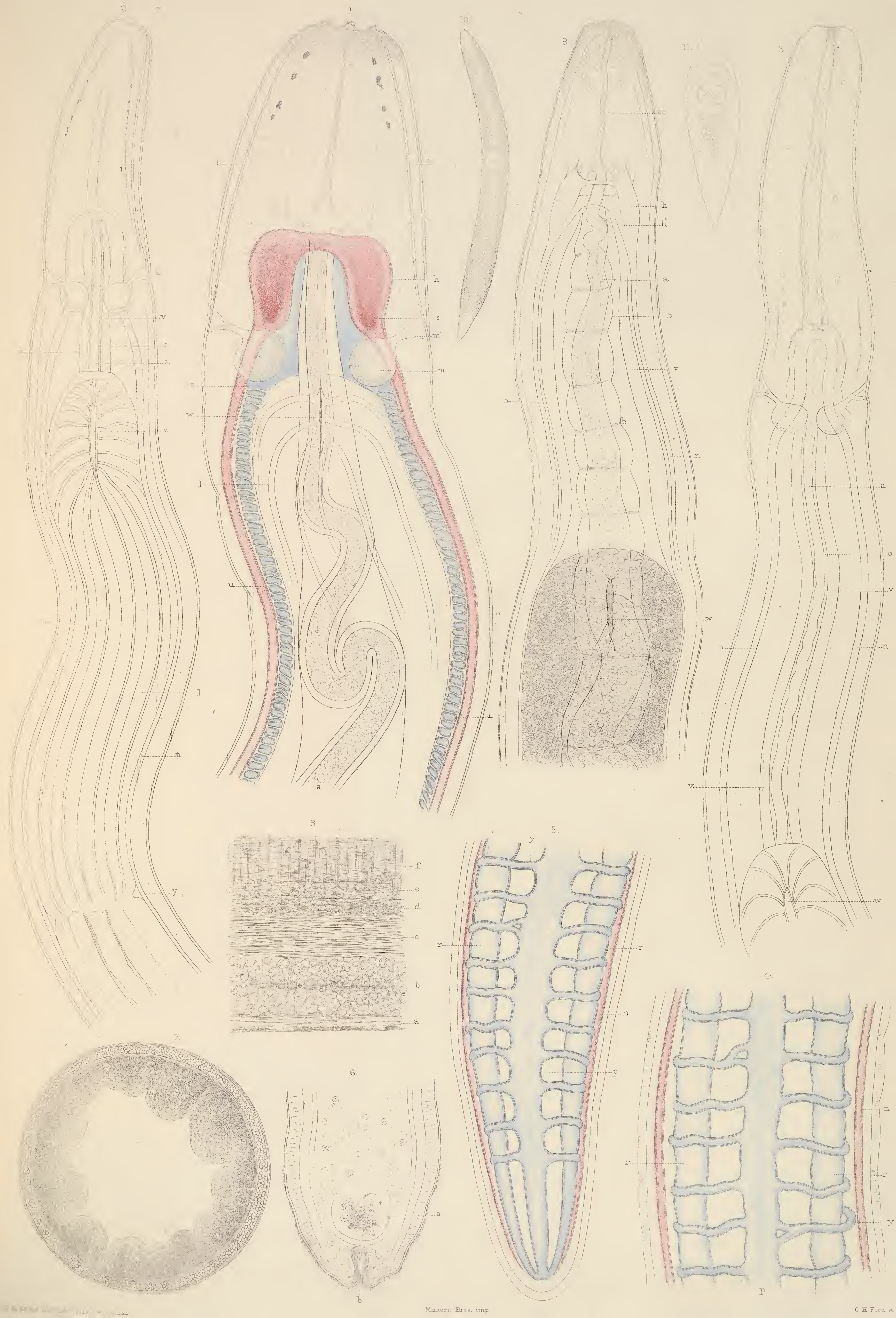
8. Transverse section of the proboscis of *Micrura fusca*. × 350 diam.

9. Highly magnified view of the anterior end of *Cephalothrix linearis*. *b*, *b*, bridles of the sheath for the proboscis.

10. Gregariniform parasite from the digestive canal of *Lineus lacteus*. × 350 diam.

11. Outline of one of the same parasites after prolonged immersion in water.

Pl. XIX.



Mintern Bros. imp.

G. H. Ford sc.

PLATE XX.

FIG.

1. Transverse section of the œsophageal region of *Lineus gesserensis* after the channel has attained full development. × 55 diam.

2. Transverse section of the œsophageal region of a large specimen of the same species in which a favourable view of the vascular meshes (*u*) around the cavity is obtained. *v*, one of the larger spaces on each side of the sheath for the proboscis. × 55 diam.

3. Transverse section of a fine specimen of *L. gesserensis* some time after spawning, and when the animal has regained its plump condition. The shriveled traces of the reproductive organs are seen at *ov*. A doubling of the proboscis in its sheath has occurred. × 40 diam.

4. Transverse section of the proboscis of *Micrura fusca*. *a*, external coat; *b*, great longitudinal muscular layer; *c*, belt of circular muscular fibres; *d*, basement-layer; *e*, incomplete series of longitudinal fibres which do not occur in the common species; *f*, glandular mucous coat; *g*, peculiar lozenge-shaped portion of longitudinal fibres, formed by the splitting and crossing of two bands from the circular muscular coat; *g'*, separate segment at the other pole of the circle. × 90 diam.

5. Transverse section of the proboscis of *Meckelia asulcata*. *a*, external spiral coat; *b*, longitudinal layer; *c*, central cavity surrounded by the glandular coat; *d*, cross of fibres at the poles. × 210 diam.

6. Transverse section of the proboscis of *Carinella annulata*. × 90 diam.

7. Gland-cells from the wall of the digestive cavity of *Amphiporus lactifloreus*. × 400 diam.

8. One of the same slightly compressed glands. × 700 diam.

9. Contents of the former, with oil-globules. × 700 diam.

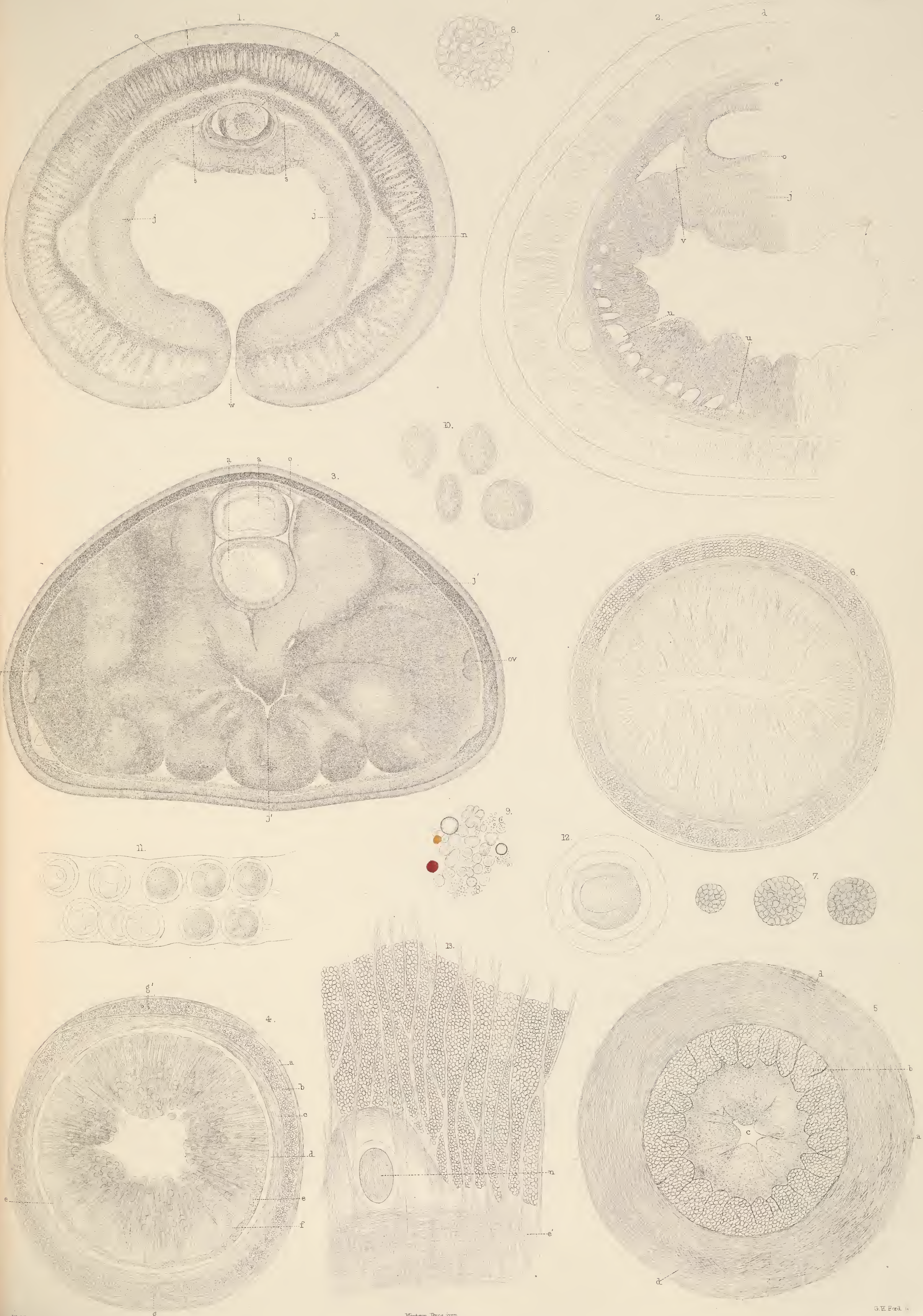
10. Pseudo-navicellæ extruded with the former parasites from the digestive canal of *Lineus sanguineus*. × 350 diam.

11. Portion of a gelatinous cord containing ova from the digestive canal of *L. gesserensis*. × 180 diam.

12. Ovum from the same. × 350 diam.

13. Transverse section of the body-wall in the region of the lateral nerve of a *Lineus* from Fetlar, showing the intricate arrangement of radiating fibres which pass through the circular coat and divide the external longitudinal muscular layer into endless fasciculi. × 90 diam.

PL. XX.



W C M ad nat. del.

Mintern Bros. imp.

G.H. Ford lith.

PLATE XXI.

Fig.

1. Transverse section of a specimen of *Lineus gesserensis* in which the ova are well developed. The shrunken condition of the walls of the digestive cavity (*j'*), with the numerous gregariniform parasites, is in strong contrast with the state of the animal after spawning. The specimen had been in spirit a considerable time before dissection. × 55 diam.

2. Transverse section of *Cephalothrix linearis*. The proboscis is coiled in its sheath. × 90 diam.

3. Transverse section of one of the *Lineidæ* from St. Magnus Bay, Shetland, in which the sheath for the proboscis is surrounded by the internal longitudinal muscular coat. × 28 diam.

4. Transverse section of *Borlasia Elizabethæ* after contraction in spirit. The enormous muscular mass forming the body-wall is well shown in this preparation. × 24 diam.

5. Transverse section of the proboscis of *Lineus marinus*. × 55 diam.

6. Transverse section of a lateral nerve-trunk (*n*) in *Lineus gesserensis*. *n'*, fibro-granular matrix, in which the nerve lies in its own proper sheath; *e*, external longitudinal muscular layer of the body-wall; *e'*, circular muscular layer. × 700 diam.

7. Cellular elements of the wall of the digestive chamber of the same species. × 700 diam.

8. Cells from the digestive cavity of a young *Cephalothrix linearis*. × 700 diam.

9. Head and proboscis of a remarkable variety of *Carinella* brought from Shetland by Mr. Gwyn Jeffreys. *b*, frilled arrangement, apparently homologous with the superior lip of the cephalic fissure; *w*, prolapse of textures from mouth. Magnified under a lens.

10. Spermatozoa of *Lineus gesserensis*. × 700 diam.

11. Spermatozoa of *Lineus sanguineus*. × 800 diam.

12. Spermatozoa of *Lineus marinus*, from a fragmentary specimen. × 900 diam.

13. Spermatozoa of *Cephalothrix linearis*. × 900 diam.

PL. XXI.

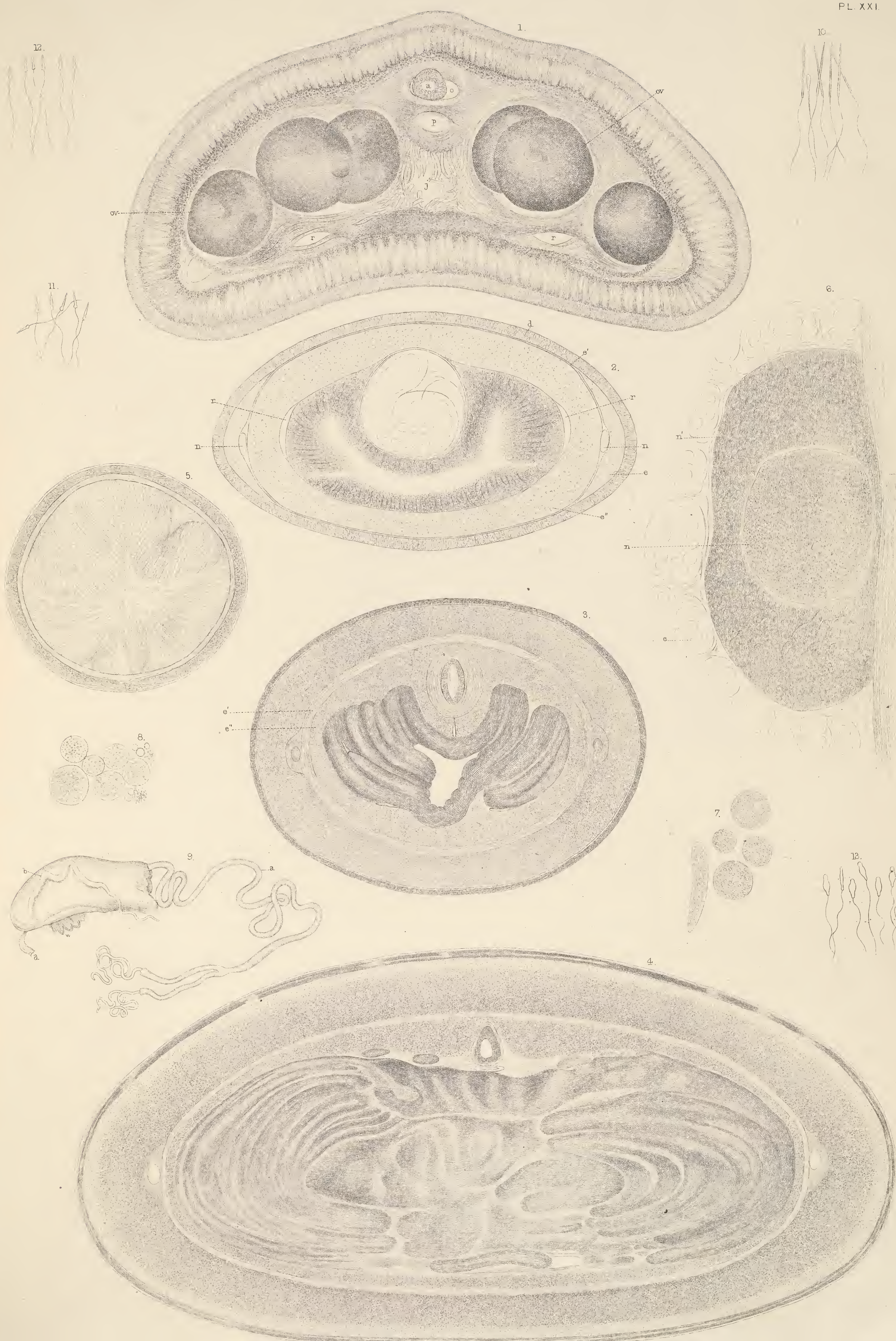


PLATE XXII.

Fig.

1. Transverse section of the cephalic ganglia of *Lineus gesserensis*. The pale central portions are caused by the imperfect penetration of the fluid in mounting. × 210 diam.

2. Transverse section of the curious variety of *Carinella* from Balta. *d*, external layer of cutis; *d′*, basement-layer; *e*, longitudinal muscular layer; *e a*, dorsal subdivisions of the latter coat in the central line; *e′*, circular muscular coat; *j*, section of the œsophageal region of the digestive tract; *j a*, distinct band of muscular fibres enclosing the latter; *n*, lateral nerve; *o*, sheath for proboscis; *r*, vascular spaces. × 55 diam.

3. Transverse section of the post-ganglionic region of *Lineus lacteus*, showing the long vascular lacunæ (*s*, *s*) in front of the œsophageal region. The slice of the proboscis has fallen out of its sheath (*o*). × 90 diam.

4. Anterior end of a contracted specimen of *L. gesserensis*, turned round so as to exhibit the marked separation between the œsophageal region and the digestive cavity proper. × 90 diam.

5. Adventitious granular mass (*a*) in a longitudinal section of the dermal tissues of *Lineus marinus*. *b*, *b*, spaces from which similar structures have fallen. Other letters as in previous figures. × 210 diam.

6. Aggregations of fatty granules from the discarded coating of the embryo of *Lineus gesserensis*. × 210 diam.

7. Anterior end of a fragment of *Lineus sanguineus*, about three weeks after rupture. *a*, terminal aperture; *d*, cutaneous layers. × about 40 diam.

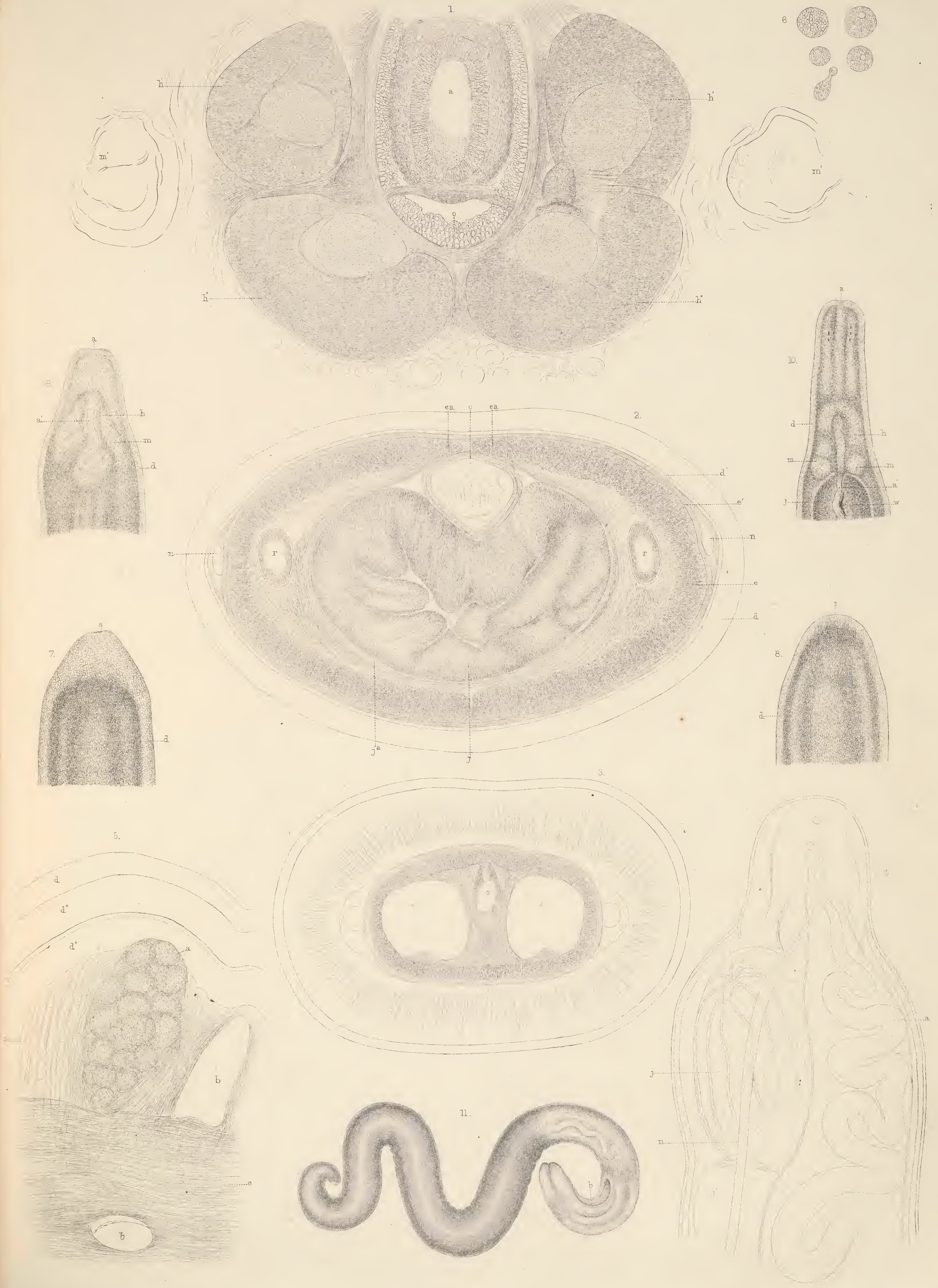
8. Posterior end of the same fragment, similarly magnified. *z*, anus.

9. Anterior portion of a fragment in a more advanced condition. *a′*, developing proboscis; *h*, indication of ganglia.

10. Anterior region of a complete, or nearly complete, animal developed from a fragment; *j*, œsophageal division of the alimentary canal; *m*, cephalic pit and sac; *w*, mouth.

11. View of a similar specimen; the regenerated anterior portion, consisting of the head and the œsophageal region of the digestive chamber, is recognized by its pallor; *b*, cephalic fissure. Magnified under a lens.

PL. XXII.



G. H. Ford sc.

PLATE XXIII.

Fig.

1. Pale oily region with germinal vesicle (*a*) and germinal dot (*b*), in an ovum removed from the body of the female *Lineus gesserensis*. × 350 diam.
2. Flask containing two ova from the mucous cord of the same species after deposition. One is simply outlined, but the other is shaded—to indicate the natural opacity. × 55 diam.
3. Flask on the second day, showing the yolk divided into four portions. × 55 diam.
4. Ovum some hours older and somewhat compressed, exhibiting the further subdivision of the yolk. × 55 diam.
5. Flask having its single ovum in the mulberry-stage. × 55 diam.
6. Flask containing three ova in the same condition. × 55 diam.
7. Flask having a ciliated embryo (about the 12th or 13th day); it remains in this condition some weeks. × 55 diam.
8. Flask enclosing two young animals, somewhat compressed. *a*, embryo forced from its ciliated cellulo-granular fatty coating, the bulk of which lies at *c*; *b*, embryo still within the ciliated coating. × 55 diam.
9. A young specimen of *L. gesserensis* immediately after leaving the flask; *b*, opening of the right cephalic sac. × 90 diam.
10. Magnified view of a young example of the same species after it has attained a considerable degree of advancement. It still possesses only two eyes.
11. Flask from the mucous cord of *Lineus marinus*. The contained embryos are nearly disintegrated from decomposition. × 55 diam.
12. Ovum of *Cephalothrix linearis* immediately after deposition. × 350 diam.
13. Embryo of the same species shortly after extrusion from the egg. × 350 diam.
14. A young specimen two days older than the preceding. *a*, mouth; *b*, granules of digestive cavity. × 210 diam.
15. An example about three days older than the last (fig. 14). × 210 diam.
16. A young specimen of *Cephalothrix linearis* after shedding the long anterior whip of cilia, but having the lateral tufts (*c*) and eyes. *a*, mouth; *b*, granules of digestive cavity. × 210 diam.
17. Transverse section of the proboscis of *Cerebratulus angulatus*, O. F. Müller. *g a*, the inner wedge of longitudinal fibres described in the text; *g b*, the outer band of longitudinal fibres. The other letters as usual. × 40 diam.
18. Stylet-region of *Amphiporus hastatus*, somewhat contracted. It has the same letters as other figures of the Enopla. × 55 diam.
19. Stylet-region of *Amphiporus bioculatus*. × 55 diam.