IX.—*On the Structure of the British Nemerteans, and some New British Annelids.*

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(Read 20th April 1868.)

The anatomy of the soft worms variously arranged under the Nemertean Order has, even in recent times, not been carried out with that completeness necessary for their thorough elucidation, a state of matters partly due to the confounding of the structure of one family with another, and predicating of the series what investigation has but proved in one group. Few British comparative anatomists have paid much attention to these animals; indeed, Dr GEORGE JOHNSTON,* Mr HARRY GOODSIR,† and Dr THOMAS WILLIAMS,‡ are the only three who have left researches of any moment on the subject. The observations of the first-mentioned naturalist were made many years ago, with the aid of inferior instruments, and, though conscientious enough, are very meagre and unsatisfactory; and those of Dr WILLIAMS, while also showing the defects just noted, bear evident traces of imagination. Mr H. GOODSIR'S interpretation of structures was, from his limited observations, likewise very erroneous. On the Continent, again, the investigators have been more numerous, and a long list of distinguished names attest the interest which the subject has received at their hands. I do not deem it necessary on the present occasion to enumerate the older writers at full length, since this has already been accomplished very satisfactorily by MM. DE QUATREFAGES§ and KEFERSTEIN,‖ but shall refer to such of their views under the respective heads as may be required for the complete elucidation of the subject. Of those, however, who led the way to a more correct appreciation of the structure of these animals, I may particularise MM. DUGÈS,¶ BLANCHARD,** and DE QUATREFAGES,§ in France; EHRENBERG,†† RATHKE,‡‡ MAX SCHULTZE,§§ and KEFER-

* Mag. Zool. and Bot. vol. i. 1837; and Catalogue of Worms, 1865.

† Annals N. Hist. xv. 1845.

‡ Report Brit. Assoc. 1851.

§ Annales des Soc. Nat. 3me ser. vi. 1846; and Voyage en Sicilie, vol. ii. par MM. EDWARDS, DE QUATREFAGES, and BLANCHARD.

‖ Zeitschrift für wiss. Zool. xii. 1863.

¶ Annales des Sc. nat. tom. xxi. 1830.

** Annales des Sc. nat. 3me ser xii. 1849.

†† Symbolæ Physicæ, 1831.

‡‡ Neueste Schrift. der Naturforsch. in Danzig, 1842.

§§ Beiträge zur Naturg. der Turbellarien, 1851; and Zeitsch. für wiss. Zool. iv. 1853, &c.

STEIN,* in Germany; ŒRSTED,† in Denmark; VAN BENEDEN, ‡ in Belgium; CLAPARÈDE,§ in Switzerland; and DELLE CHIAJE, ‖ in Italy.

The confusion in regard to the structural characteristics of the order is well illustrated in the descriptions given in the lately published "Catalogue of the British Museum," and in the first chapter of Dr COBBOLD'S "Entozoa," where little else than an array of doubts is produced as a solution of this question. In France, again, the valuable Lectures of M. MILNE EDWARDS,¶ for instance, are chiefly of interest on the subject of the Nemerteans as stimulants for further investigation. An examination of the discrepancies existing between the comparatively recent and excellent researches of MM. DE QUATREFAGES,** MAX SCHULTZE, CLAPARÈDE, VAN BENEDEN, and KEFERSTEIN, demonstrate the same necessity for further elucidation. MM. DE QUATREFAGES, VAN BENEDEN, and KEFERSTEIN have, perhaps, gone more minutely than the others into the question, but all have confounded the structure, or certain parts of the structure, of the Ommatopleans with the Borlasians, whether one or both groups have been examined. M. DE QUATREFAGES investigated the Ommatoplean group more extensively than the Borlasian; while Prof. KEFERSTEIN paid more attention to the latter; but he has not entered so minutely into structural detail as the former, though his observations are, on the whole, more exact. VAN BENEDEN likewise predicated of one group what he had found in the other, and hence sometimes gave an erroneous interpretation of the parts. While thus reviewing the labours of these distinguished naturalists, it must not be understood that I in the least degree undervalue their investigations; but rather, that from a more continued series of observations, structures—about which they were in doubt—have been more clearly determined, and many additional facts brought to light. Indeed, no one who is acquainted with the patience and experience necessary for unravelling the anatomy of these delicate creatures, will wonder at the occurrence of errors of omission or commission, either in the labours of others or his own. Ever restless when alive, prone to rapid dissolution when dead or too much pressed, and comparatively few of the requisite transparency for examination, it is only by a happy combination of circumstances that the structure of these animals can be successfully demonstrated.

One of the main objects of this paper is to show the essential differences between the Ommatopleans and the Borlasians, from the skin even to the micro-

* Zeitschrift für wiss. Zool. xii. 1863.
† Entwurf einer Syst., &c., der Plattwürmer, 1844.
‡ Memoires des Sc. des Acad. Roy. de Belgique, tom. xxxii. 1861.
§ Recherches Anatomiques, &c., dans les Hebrides, 1861.
‖ Mem. sulle Storia, &c., vol. ii. Naples, 1825.
¶ Leçons sur la Physiol. et l'Anat. Comparée, tom. 5^{me}, pp. 460–65.

** In his "General Outline of the Animal Kingdom," 3d edit. 1861, Professor RYMER JONES strictly follows this author.

scopic structure of the proboscis, as well as to advance our knowledge of the minute anatomy of these animals and their immediate allies.

I use the terms Ommatopleans and Borlasians provisionally in the meantime, because the majority of these soft animals group themselves round two centres, represented respectively by the common *Ommatoplea alba* and *Borlasia olivacea.* The terms, indeed, are nearly equivalent to MAX SCHULTZE's *Enopla* and *Anopla*, and to Prof. KEFERSTEIN's *Tremacephalidæ* and *Rhochmocephalidæ*. I do not think it advisable to call by the name of Borlasia, as the last-mentioned author has done, a family whose structure is quite different from that of the animal originally so termed, and hence I have preferred EHRENBERG's name, *Ommatoplea*, on the one hand, and substituted *Borlasia* for KEFERSTEIN's *Nemertes*, on the other, both because it (*Borlasia*) has the priority, was applied to an animal similar in structure, and because there are strong claims to perpetuate the name of the early English zoologist. So comprehensive are the above terms, that almost in every minute particular all the known British forms, with the exception of Cephalothrix and another, resolve themselves at once under their respective heads.

Ommatoplea alba (and variety *rosea*) may, as above mentioned, be conveniently taken as the type of the Ommatoplean group, both from its size and abundance, and accordingly a systematic examination of its anatomy shall first engage our attention, the additional observations made on its immediate allies being appended and contrasted therewith. It is also fair to state, that I could not have pursued the following inquiries if a liberal and ever-ready supply of living animals from the St Andrews' rocks had not been perseveringly forwarded by a relative, to whom I owe the deepest obligations in this and other departments of zoology.

Dermal Tissues.—The body of the animal, like that of each in the Order, is universally covered with cilia, some longer ones being present at the proboscidian aperture and mouth, and others at the tip of the tail. The ciliary motion is most active at the openings of the cephalic pits. In *Tetrastemma variegatum,* it is interesting to watch the cilia at the anterior end, especially around the aperture of the proboscis, as the long cilia bend outwards and inwards with a less rapid motion than the shorter. Those at the posterior end cause a complete vortex, the longer cilia often remaining quiescent. The granules in the surrounding water are directed by the cilia of the sides of the tail towards the tip, where, after coming in contact, the two opposing currents dash outwards, frequently again to curve round, and cause their granules to come under the action of the lateral cilia. The whole appearances very much resemble the currents of water in a vessel after the application of heat. This action would be of little service to an animal whose posterior end was quite closed. The cilia, as long known, perform a respiratory function ; at least there exist no other special organs for the purpose.

The skin is somewhat opaque, and presents a cellular or cellulo-granular appearance. In a small living specimen it is represented as a transparent object in Plate IV. fig. 8, the entire field being definitely covered with glandular cells, and the reddish pigment grouped here and there in varying and irregular granular masses. On snipping a portion of skin from an adult living specimen, and placing it under moderate pressure (Plate IV. fig. 3), it presents the aspect of a series of ovate or spathulate cells, which contain soft and minutely granular contents, interspersed with large clear masses of mucus (like oil) of a somewhat similar figure, the latter becoming more numerous as the pressure increases. There are also numerous pigment and other granules scattered over the field. Changes, however, rapidly ensue in this delicate texture, as noted by M. DE QUATREFAGES, both in this group and in Planaria, and the masses of mucus pass rapidly to the nearest free border and there accumulate, the granular contents of the cells following a similar course, but not coalescing. Some of these free globules are shown in Plate IV. fig. 7, *a* being the granular masses, and *b* a group of mucous globules like oil. The former structures, though very mobile, are less so than the latter. A transparent gelatinous basis-substance, often of a reticulated aspect, remains after the extrusion of the foregoing elements from the skin.

When a transverse section is made of an animal hardened in spirit and mounted in chloride of calcium, the appearance of the dermal textures (Plate IV. fig. 2) is as follows:—In rapidly prepared and newly mounted specimens, a structureless film is sometimes observed to separate from the exterior of the skin, as indicated by the double line at the edge of the figure. Chloride of calcium would seem to destroy this delicate structure, as after a time it becomes indistinct, and I have not seen it in those hardened in chromic acid. The cellular cutis (*a*) is found to have undergone an alteration, being streaked perpendicularly, an appearance due to the collapsed state of the areolæ and cells, whose contents to a greater or less degree have escaped, and thus given greater prominence to the hyaline intercellular substance. It is granular throughout, and rather more so towards the outer and inner edges. In most of the transverse sections, the pressure of the cover has caused flattening of the skin, so that the increased cellular appearance of the outer edge is partly due to the fact that the texture is seen from the surface, 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, especially in those much hardened or slightly exposed to air, spurious annulations are caused by the folding inwards or wrinkling of the skin, but such crenations do not affect the muscular layers, and have no connection with the segmentation of the digestive chamber, or true annuli. A thin longitudinal section from the surface of the skin shows a series of meshes with crenated edges, the size of the spaces being variable. In *Omma-*

toplea purpurea and *O. gracilis* the cells of the skin are much smaller than in *O. alba*. In *O. gracilis*, indeed, the skin resembles microscopic mosaic work, from the granules and plaits in each space or cell.

The function of this elaborate glandular arrangement is doubtless 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 rapidly form a sandy 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 not, the animal took full advantage of the protection. The same habit is extensively followed by the Ommatopleans 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 proved to be a minutely granular fluid, intermingled with a few larger corpuscles. The silky sheaths formed by *Tetrastemma variegatum* and others are well-known examples of this cutaneous secretion. The tube constructed by *Polia involuta*, VAN BEN.,* is the densest yet seen, and it has an areolar aspect, from the granules or globules being set in a hyaline matrix, sometimes at considerable intervals from each other. Moreover, when viewed in profile, these globules are found to be elevated above the external surface, like a series of low pale warts. M. BENEDEN says it is simply tesselated. The tube is attached to the hairs of the abdominal feet of female crabs (*C. mœnas*) bearing ova, and is evidently of intrinsic importance to the species, both as a protection against injury and desiccation. That some of the characters of this group of worms are due to the thick and soft cutaneous layers is demonstrated by the appearance which they present when such are removed, as by improper preservation. Two specimens of *O. pulchra*, dredged off the Hebrides by Mr JEFFREYS, were in this condition; and as the proboscis had been thrown off in the one first examined, it appeared like a new type of non-bristled worms, characterised by the simple arrangement of its digestive system, and its glistening and elastic investment, so different from the dull, whitish, and non-elastic covering of an ordinary preparation.† Another interesting feature in regard to the skin of the Ommatopleans (in common with the Borlasians), is the reaction which ensues on testing with litmus-paper. In this group an acid reaction occurs in *O. alba*, *O. melanocephala*, and *O. gracilis;* while, on the other hand, a reaction not less distinctly alkaline characterises *O. purpurea* and *O. pulchra*.

M. DE QUATREFAGES' description of the tegumentary structures differs materially from that just given, a discrepancy arising partly from his confounding the

* *Nemertes carcinophilus*, Kölliker.

† The comparison of the external tissues of certain remarkable processes, occurring on a new Annelid from the Gulf of Suez, to the Nemertean skin, as described by M. LE Dr LÉON VAILLANT in the "Ann. des Sc. nat." for 1865, is certainly far fetched and unlikely. The processes referred to are considered buds, but they seem to me to be no more buds or parasites, than the processes on the long tentacles of our British *Mœa mirabilis*.

structure of *Ommatoplea* (his *Polia*) with *Borlasia*, and partly from incorrect observations. He refers to the cells or areolæ of the integument as "simples vacuoles ovoïdes ou arrondies," which refract light, takes no note of their contents, and apparently considers them empty. His separation of the skin into two layers, the exterior composed of smaller, the interior of larger cells, is not evident in Ommatoplea. 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" layer, which is described as lying within the former, is our structureless basement-layer. Dr 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. Prof. KEFERSTEIN's observations on the cutaneous and muscular structures apply almost entirely to our Borlasians.

Muscular Layers of the Body.—A very distinct belt of circular muscular fibres (Plate IV. fig. 2, *c*) occurs next the basement-layer of the cutis. They (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 wall of longitudinal muscular fibres, which, in transverse sections, is generally somewhat crenated on its 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. The muscular coats in Tetrastemma are formed on the same plan as the foregoing. The appearances of these muscles in transverse section resemble those recently given by Professor KÖLLIKER of the muscles in crabs.† Thus there are only two distinct muscular coats of non-striated fibres around the body of the Ommatopleans, making an essential difference in this respect between them and the Borlasians, to which (latter) previous observers have for the most part confined their investigations.

M. DE QUATREFAGES describes the muscular coats both in Borlasia and Nemertes (specially instancing *Nemertes balmea*, our *Ommatoplea gracilis*), as consisting of "external longitudinal and internal transverse" fibres. In Ommatoplea, as just described, it is exactly the reverse, the circular fibres being external, and the longitudinal internal. He also speaks of another layer, within the internal, as forming an aponeurosis, apparently referring to the fibrous prolongations from the internal or longitudinal coat.‡ Thus Sig. DELLE CHIAJE, instead of being in error, as averred by M. DE QUATREFAGES, is correct in stating that the external coat is circular, and the internal longitudinal. Physiologically, it is certainly a

* Beiträge zur Naturges. der Turbellarien, tab. vi. fig. 4.

† Zeitsch. fur wiss. Zool. bd. xvi. 1866, p. 375.

‡ VAN DER HOEVEN, apparently from following M. DE QUATREFAGES, makes the same errors —*Handbuch der Zoologie*, vol. i. p. 212.

better arrangement for such an animal, which has only two muscular coats, to have the longitudinal fibres internal, for, on the occurrence of rupture, they, as well as the other tissues, are constricted 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 mollusca, by aid of the mucous exudation, and not, as stated by M. DE QUATREFAGES, chiefly by the cilia.

Anteriorly the body-wall terminates in a rounded snout—of the usual cutaneous textures, presenting in transverse section an areolar and granular appearance, the soft contents of the areolæ having for the most part escaped. The aperture for the proboscis lies at the ventral border of such a section. Somewhat behind this, but yet in front of the ganglia, a remarkable interlacement of fibres (Plate IV. fig. 1), occupying almost the entire cephalic region, occurs. Powerful bands of fibres (**1**) pass below both the buccal cavity and the tube for the proboscis, meet, and cross each other in an oblique manner, forming 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 of the fibres (**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. The fibres (**4**) that meet above the central canal cross each other obliquely in the middle line, so as to form a firm arch; and, besides, there are some transverse fibres (**5**) that cross over the canal, and spread out on each side. Other bands of fibres (**6**) slant downwards and inwards on each side of the cavity, and meet inferiorly. The arrangement of these bands and fibres is so intricate, that each seems to blend with the other, and form a continuous anastomosis of contractile meshes. In addition to these oblique and radiating fibres, there is a powerful series of longitudinal fibres interwoven with them in an intricate 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 afford 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. This will be understood by referring to Plate IV. fig. 5, which represents a section of an animal which had protruded a small portion of its proboscis after chloroforming and immersion in spirit. The inferior commissure of the ganglion is thus somewhat protected by the arrangement of the fibres in front of it. The blood-vessel (Plate IV. fig. 1, *l*) lies on each side in a sheltered position, in an angle between two series of fibres; and its calibre would not seem to be much interfered with except in extreme protrusion of the proboscis. 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 this 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 also must 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 granular elements, is less dense than in Borlasia, and the interlacing of the fibres, though not more complex, is more beautiful, because possessing greater distinctness and regularity.

The posterior end of the body has no such intricate arrangement, but the muscular fibres blend together at the tip and close in the cavity, with the exception of the small and sometimes indistinct opening of the great longitudinal digestive chamber. The modes of fracture of these muscular coats in some of the Ommatopleans in a sick and perishing condition are interesting, the body being separated into a number of beads from the constriction and rupture of the body-wall at somewhat regular intervals.

My observations would lead me to follow a different arrangement in the description of the cavities within the body-wall, from that pursued by MM. DE QUATREFAGES, KEFERSTEIN, and VAN BENEDEN, since there exist some differences as regards interpretation of structures. Instead of speaking of a "general cavity of the body," I shall first refer to that chamber in which the proboscis lies, and which may be termed the cavity of the proboscidian sheath.

Cavity of Proboscidian Sheath.—In *Ommatoplea alba* as well as in *Tetrastemma*, this chamber commences 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 shown in Plate VI. fig. 1, where a fold (*a*) from the tube of the proboscis becomes attached to the parenchyma of the head, or where, instead of a canal (*ab*) simply hollowed out in the tissues of the head, free and dictinct walls to the proboscis become apparent. This reflection is the anterior boundary of the proboscidian sheath under ordinary circumstances, and it is against this obstruction 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, when viewed from above, as a transparent object, is seen in Plate VI. figs. 3 and 8, but it varies much according to the position, degree of extension or contraction of the animal, sometimes almost clasping the elongated proboscis, at others being attenuated 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 arching of the superior commissure, the inferior commissure, and the sides of the ganglia. The nervous matter must thus occasionally undergo very great stretching, 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 IV. fig. 5, will suffice in the present instance. The inferior commissure separates it entirely from the chamber of the great ciliated œsophagus. The relation of the parts in the ganglionic region is represented in Plate V. fig. 1, *o* being the wall of the proboscidian sheath somewhat compressed, so as to show both longitudinal and circular fibres; for it may be mentioned, that the structure of the chamber wall is powerfully muscular, as evinced by its ever-varying condition. At this point, however, the fibres have not attained a great degree of development. In a section made further back (as in Plate V. fig. 2, *o*), and in the other transverse sections, this muscularity is more distinctly exhibited, though, of course, the spirit has shrivelled all the parts, especially the muscular. Externally the wall of the chamber is furnished with a layer of circular, and internally with a series of longitudinal fibres, both becoming thinner posteriorly. The comparatively large size of the cavity during life has doubtless caused several observers to err, by confounding it with the supposed general cavity of the body. The presence of ova or sperm-sacs has a considerable influence in modifying the size of the chamber, 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 cavity exists posteriorly in the ripe animal, for this chamber 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 absent in the aberrant form *Polia involuta*, VAN BENEDEN.

In the foregoing cavity the proboscis floats in a clear fluid, rich in large flattened discs, which have a minutely granular appearance. In the living animal, these generally have a fusiform outline, from a slight thickening in the middle (Plate IV. fig. 9, *b*). They are accompanied by certain granules and globules, which are also represented in this figure. The discs vary in size, and adhere together in a dying animal very easily, from the highly 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 organised, and very different from sea-water, to which Dr T. WILLIAMS compares it. When the proboscis has been gently protruded under chloroform, the discs in the interspace may by-and-by be seen grouping together, so as to form stellate bodies, resembling miniature solasters, spiked bodies like thorn apples, flattened structures with pectinate ends, and various other forms. In *O. melancephala* the discs 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 discarding of a proboscis, is well seen in this species. In *Tetrastemma* the discs (Plate IV. fig. 14), though similar in shape to those of *O. alba*, are comparatively large; and in a variety of *T. varicolor*, which I am at present inclined to regard as the *Polia sanguirubra* of M. DE QUATREFAGES, they are tinged pinkish or reddish by transmitted light (Plate IV. fig. 11). They are not all similarly tinted, some being pale, others yellowish, while many are bright red—the colour in all cases being in the nuclei. Circular bodies and granules are present, as in Ommatoplea. 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 *O. alba*, and in other species of *Tetrastemma*, generally associated with reddish specks in the skin; and it is curious that a cast-off proboscis in *T. algæ*, and other species, assumes the same hue by transmitted light. With the foregoing exceptions, the only changes noticed in the colour of the discs were those caused by refraction of the rays of light. After extrusion into the water, their shape soon alters, and they adhere together, and become translucent.

M. ŒRSTED* gives a small figure of a transverse section of his *Notospermus flaccidus*, and characterises the proboscidian cavity as "canalis in quo penis est," indicating by a blank beneath what might have been the digestive tract. His interpretation of structures, however, is more distinct in his section explanatory of the Family Amphiporina,† in which the digestive cavity is correctly alluded to.

The reflection of the walls of the proboscis before-mentioned, in front of the ganglionic commissures, is the only barrier (and a very effectual one) I have observed separating the proboscidian chamber from the tissues of the head. In no species examined has such a cephalic diaphragm as described by M. DE QUATREFAGES been found; but the peculiar ciliated chamber or 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. This author, while explaining a transverse section through *Nemertes Borlasii*‡ (vel *Borlasia Angliæ*), shows a canal surrounding the proboscis; but in his description he confounds it with the general cavity of the body, and figures (fig. 5 same plate) the proboscis as

* Entwurf einer syst. Eintheilung, &c. der Plattwürmer, tab. iii. fig. 51.

† Entwurf &c., p. 94, fig. 18 (woodcut).

‡ Recherches Anat. and Zool. vol. ii. pl. xviii. fig. 4.

occupying the centre of the general cavity posteriorly. This description, no doubt, refers to a Borlasian; but he states that the same arrangement occurs in the Ommatopleans, and represents in *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 œsophagus occupies this situation, and has probably misled the observer. The somewhat erroneous views he entertained with respect to the relations of the corpusculated fluid of the proboscidian chamber may be seen by a glance at one of his figures,† which depicts in *Polia sanguirubra* the proboscidian bodies as floating in what he calls the genital cavity, and in which the genital cæca are supposed to lie. I cannot corroborate his statement that these discs become much more numerous at the epoch of reproductive activity. The diminished size of the chamber may cause a slight crowding anteriorly, but this is not an increase. He did not recognise the complete muscular sheath for the proboscis and the proboscidian fluid. Dr JOHNSTON likewise confounded the cavity-proper of 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,§ however, alludes to the sheath for the proboscis in *Polia obscura*, and compares the fluid and discs therein to pale blood. Professor KEFERSTEIN,‖ again, follows the majority of his predecessors, in so far as he also describes the proboscidian discs as floating in the general cavity of the body, in which, moreover, he locates the proboscis (Rüssel); thus ignoring the special and complete muscular sheath just described.

The structure of the proboscidian discs, and the highly organised 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 the curious *Polia involuta*, VAN BEN., especially to those who, like the late Dr WILLIAMS, consider the fluid analogous to the peritoneal or perivisceral fluid in the true Annelids—a fluid, we may remark, which Professor HUXLEY¶ considers as the true blood, while he thinks the red fluid in the branching vessels analogous to the water vascular system in the Annuloida. If in *Polia involuta* 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

* *Op. cit.* fig. 1, pl. xviii., and fig. 1, pl. xix.
† *Op. cit.* pl. xxii. fig. 1.
‡ Report, Brit. Assoc. 1851.
§ *Op. cit.* p. 26.
‖ Zeitsch. für wiss. Zool. xii. pp. 69 and 71.
¶ Notes of Lectures at the Roy. Coll. Surgeons, *Med. Times and Gaz.*, March 7, 1868.

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 discs 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 debris of the discarded organ when it happens to be included in the chamber. But while thus affirming 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 for the appearance of the latter, since there is a small proboscis in *P. involuta*, where the fluid is altogether absent. The views of Dr THOMAS WILLIAMS in regard to this corpusculated liquid, which he termed the "chylaqueous fluid," are so much at variance with accuracy, that I cannot pass them over in silence. He says—"In the case of the Borlasiadæ, Planiariadæ, 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 organisation. 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."* The above clearly shows that he was quite unaware that the so-called "elliptical cells" are always confined within the cavity of 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 is required, but certainly not for the purpose of converting it into "a *vital* organised fluid." The proboscidian fluid and discs, as I have previously shown, are very far removed from sea-water.

In the Ommatopleans, the aperture for the extrusion of the proboscis 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 IV. fig. 13). It is furnished with longer cilia even in the young animal; and in the adult these (cilia) form, when the lips are slightly pouting, a very pretty arrangement (Plate VI. fig. 1, *a c*), similar to the analogous opening in Borlasia (Plate X. fig. 1). The striated ring

* Phil. Trans. Part ii. 1852, p. 627, pl. xxxii. fig. 25.

surrounding this orifice in transverse sections of the tip of the snout indicates the special muscular coat pertaining thereto. The canal proceeds in a straight line backwards from this aperture to a point in front of the commissures of the ganglia, where it meets the differentiated walls of the proboscis, as shown in Plate VI. fig. 1, *a b;* and the cilia can be traced backwards to this region, but no further. This canal is simply hollowed out in the tissues of the head, and is quite independent of the motions of the proboscis. It is furnished with a series of longitudinal muscular fibres beneath the ciliated mucous surface, and the strong oblique and circular bands (Plate IV. fig. 1) form a very efficient constricting investment. When the proboscis is about to be ejected, it commences to fold over like the turning of the finger of a glove inside out, at the point (Plate VI. fig. 1, *a*) in front of the ganglionic commissures, and not at the tip of the snout, a fact which has escaped previous 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 is seen slowly passing backwards till this point is reached, when the wrinkle ceases, and the organ is once more in its ordinary condition, any change that afterwards ensues being due to the stretching of the shortened organ backwards—a process of simple elongation. Thus the anterior portion structurally and functionally differs from the succeeding, the walls 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 walls of the foregoing canal and other cephalic tissues just in front of the ganglia; and so the reflection constitutes the *point d'appui* against which the wave of proboscidian fluid impinges, when the organ is about to be extruded. The thin anterior walls of the proboscis unroll, the terminal canal is distended by a pouch of fluid, and then the organ is rapidly launched forth. To judge from the description and drawings of M. DE QUATREFAGES, the entire force of this liquid would dash against the posterior part of his nerve-ganglia, and the straitened border of his hypothetical "diaphragm" would not pass further forwards. 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 says, is to dilate the "oral" orifice, and carry the "gullet" forwards; but the elaborate stroma, shown in Plate IV. fig. 1, 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 forwards and outwards from the tube, especially when that is drawn backwards. On the other hand, when the tube is thrust forwards, the fibres slope forwards and inwards.

Dr JOHNSTON, M. DE QUATREFAGES, and Dr WILLIAMS agreed in considering

* *Op. cit.* pl xix. fig. 1.

the terminal aperture the mouth, and indeed it could not be otherwise, since the proboscis was regarded by them as the true alimentary organ. My observations, while leading me to differ from M. VAN BENEDEN and Professor KEFERSTEIN, who aver that the Ommatoplean mouth is situated on the under surface *behind* the ganglia, as in the Borlasians, coincide with the three former only in so far as this anterior opening lies close to the real mouth (communicating with the ciliated sac or œsophagus). Dr MAX SCHULTZE, almost alone amongst foreign authors, seems to have noticed the true position of the mouth in his *Tetrastemma obscurum*. The aperture for the proboscis lies just at the ventral border of the snout, while the mouth forms a slit on the ventral surface immediately behind the former. In this respect, therefore, there is a marked distinction between the Ommatoplea and its allies on the one hand, and Borlasia and Cephalothrix on the other, the mouth in the first group opening quite in front of the ganglia, while in the other it is situated considerably behind the ganglia. Analogy gives no grounds for supposing the proboscis to be the alimentary organ.

I shall divide, for convenience of description, the Ommatoplean proboscis into three regions, viz., the anterior, middle, and posterior. The first (Plate VI. fig. 3, A) comprehends that somewhat cylindrical portion between the reflection in front of the ganglionic commissures and the commencement of the stylet-region —the *trompe* of M. DE QUATREFAGES; the second (B) includes the stylet-region proper and the well-marked swelling of the great muscular sac—the œsophagus of M. DE QUATREFAGES; and the third (C) is represented by the long posterior gland—the *intestin* of M. DE QUATREFAGES.

Anterior Region of Proboscis.—From the point of reflection backwards, the proboscis (*trompe*, Rüssel) gradually increases in diameter until its full size is attained. The entire organ is proportionally on a larger scale than in Borlasia, and its anatomy more apparent; though I doubt, even in this group, if we can assign it the ideal office of a vertebral column. The general appearance of the commencement of the organ in *O. alba* is seen in Plate VI. fig. 3, and in *Tetrastemma algæ*, in Plate VIII. fig. 3. At the point of reflection there is sometimes seen a kind of *os*, from the slight turning over of the lips of the organ in the early stage of ejection (Plate VI. fig. 1, *a*). This figure also represents the longitudinal fibres of the proboscis as most conspicuous in this region. Sometimes the organ assumes a twisted position under examination, so as to give the fibres a spiral appearance, and in such a state the structure might fancifully be likened to the spiral arrangement of the muscular fibres in the œsophagus of the higher animals, but the condition 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*,* which (organ) is described and figured as having regular spiral belts at its commencement.

* *Op. cit.* plate xx. fig. 3.

The anterior fibres of the proboscis, as further shown in the various transverse sections, and in the ruptured organ when extruded, are chiefly longitudinal, and while the thinness of the coats renders the exact structure of this region in transverse section less distinct, a very definite arrangement is observable as soon as the tube has attained larger proportions. Dr JOHNSTON, indeed, considered the organ to be homogeneous;* and M. DE QUATREFAGES describes its commencement in *Polia mutabilis* as consisting of two longitudinal muscular coats, separated from each other by a cellular layer, which, he explains, is a provision for enabling these muscular coats to act independently. He also observes, that no circular fibres were seen in this species, in *P. filum*, and some others. In very small specimens of the British examples the transparency of the tissues 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, there is a layer of what appears to be elastic tissue (Plate IV. fig. 4, *g*, Plate V. fig. 4, *g*, &c.). It is more distinctly striated in transverse than in longitudinal sections of the organ, hence it may be inferred that its fibres are chiefly circular in direction, as seen on comparing the last-mentioned figures. Towards its free border, also, certain obscure granular markings observed in the longitudinal section (Plate IV. fig. 4), show that the direction of the external fibres is different from the others; indeed, in some views, the appearance is such as to raise a suspicion of the presence of the cut ends of a few fine circular muscular fibres, the rest being nearly homogeneous. Within this is a somewhat narrow belt of longitudinal muscular fibres (*f*, same figures), which may be termed the *external longitudinal muscular coat*. It consists of pale, unstriped muscular fibres, whose cut ends are seen in Plate V. fig. 4. Intervening between this coat and the other longitudinal layer is a remarkable stratum, the *reticulated* or *beaded layer* (*e*), in the same figures, which in transverse sections (Plate V. fig. 4) assumes a regularly moniliform appearance, from an increase of its constituent substance at certain points. In longitudinal sections, I was for a time puzzled by the appearance of the cut ends of fibres in this layer, as if it had been composed of circular fibres; and a more minute examination showed that such was due to certain intermediate bands which passed between the thicker or beaded portions. If a thin longitudinal slice from the organ in *O. pulchra* is hardened and mounted in chloride of calcium, numerous well-marked homogeneous longitudinal belts are seen at regular intervals, from one end of the anterior region of the proboscis to the other, and between them are many connecting transverse fibres, which pass from each edge of the belt. The cut ends of the fibres in the longitudinal sections have therefore been caused by the knife severing the transverse meshes between two longitudinal belts. Thus the tube is surrounded by a complete investment of this

* Catalogue Brit. Museum, p. 285.

homogeneous though complex layer, which, doubtless, has its physiological use in the varied movements of the organ. The next layer (*d*, same figures) consists of a strong coat 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 this organ, present a much coarser appearance in transverse section than after hardening in chromic acid. It may be mentioned also, that there is a considerable histological difference between these muscular fibres and those in the higher animals, such as absence of nuclei and greater homogeneousness. The fifth layer from without inwards is a strong band of circular fibres (*c*, same figures), the *circular muscular coat*, which forms a counterpoise to the preceding. Lying on the inner side of these fibres is a *basement-layer* of pale translucent texture, best observed in the longitudinal sections (Plate IV. fig. 4), where it is marked *h.* In transverse sections this coat is apt to be confounded with the inner layer of circular fibres, but the distinction between the two is sufficiently apparent in longitudinal sections. It has, on the whole, a cheesy or cartilaginous aspect. Upon this layer rest the peculiar glandular papillæ, which arise from a distinct margin on its inner edge, as indicated at *b* in the last-mentioned figure, where some of the basal streaks of the papillæ are represented. A glance at the other figures will show the relations and proportions of these organs. In the ordinary transverse sections of the proboscis they form *en masse* a somewhat foliated or frilled arrangement, often more strictly symmetrical than the view here given (Plate V. fig. 4). In some contracted specimens they block up the entire cavity, or else a transparent mucous film which has exuded from them does so. The form of the glands in the fresh specimen under pressure is seen in *O. alba* in Plate V. fig. 7, and in *Tetrastemma* in Plate V. figs. 6 and 11. The largest glands 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. In typical examples of *Tetrastemma variegatum* the glandular papillæ are leaf-shaped, and somewhat crenated at the free border, where there is a regularly streaked appearance from the arrangement of the globules. Under pressure they are granular in the interior, and furnished with numerous globular or wedge-shaped mucous masses, that refract the light like oil. Sometimes in *O. alba* they present a coarsely fringed appearance, with large granules in their interior; and when the tube has been turned inside out, they have a villous aspect, the tough mucosity adverted to above projecting in strings from the papillæ under the slightest pressure. I have generally observed also, towards the first portion of the protruded organ, fine motionless processes like cilia projecting from the apices of the glands, and they are probably homologous with the minute spikes which occur on the glands of the posterior region after rupture from pressure.

The foregoing description of the structure of this region differs much from that given by M. DE QUATREFAGES, almost the only author who has entered into the minute anatomy of the Ommatoplean proboscis. He states, like Mr H. GOODSIR,* that externally the tube is furnished with a series of transverse muscular bridles, which maintain it in position within the body of the worm, and he gives a section of the parts in *Nemertes balmea*, which bears out his description very well; but he did not observe that if such bridles exist, they would have to pass through the muscular sheath in which the proboscis glides, before reaching the body-wall of the animal. Apparently he has not made out the two diverse structures. His minute anatomy of the proboscis is chiefly taken from the examination of *Borlasia Angliæ*, and hence cannot apply in any degree to the Ommatopleans, though he considered it the type of both. He makes out 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. These longitudinal coats are separated, says he, 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 coat will give the two longitudinal muscular coats that independence of action necessary for the proper performance of their functions. No such cellular layer has been seen in the British species, but between the two longitudinal coats there is found the remarkable reticulated layer. 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 are present in this organ. Professor KEFERSTEIN does not enter into the structure of this region in Ommatoplea.

Middle Region.—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 lateral stylet-sacs, and a central one in the pit of the cavity connected with the peculiar reservoir which succeeds.

The walls of the proboscis undergo a considerable change in this region, especially in regard to the deeper layers. Externally there is the investing coat continued from the anterior region on to the commencement of the reservoir (Plate IX. fig. 11), and which has a crenated border in the contracted state of the

* Ann. Nat. Hist. xv. 1845.

parts, with transverse markings or rugæ; but such an appearance does not of necessity mean that it is composed 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-region, 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 IX. fig. 3) merits special notice, since it has certain important functions to perform. The large glands of the inner wall gradually diminish in size until the floor is covered only by small, densely arranged, and minutely granular processes, so that the whole forms a somewhat sharply defined border, which in the ordinary state of the parts knuckles backwards all round the central stylet in the manner shown in the figure, becomes firmly bound together so as to co nstitute a sphincter for the aperture, and gently bending outwards and backwards, is 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 sac 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, is outwards and backwards, as shown in the drawing, 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 forms a cone whose apex is directed forwards (Plate VI. fig. 2). In the latter position the secure binding of the fibres which knuckle round the central aperture just permits the stylet to project, but 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 or pit of the cavity is pouted forwards (Plate XII. fig. 9), causing a radiated or slanting appearance of the fibres. A firm constriction of the tube just in front of the stylet-region often takes place, separating the pit of the organ from the more glandular region in front, and causing a double swelling of the parts. Just in front of the stylet-sacs lie some coarse granular glands, which, however, are less conspicuous than in *O. gracilis* and others. Professor 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 *Ommatoplea alba* or *Tetrastemma*, as the entire apparatus is either translucent or white; but in certain species, as will hereafter be shown, an increase in the granular matter occurs. The longitudinal fibres of the last-mentioned author end at the posterior border of the stylet-region.

The *Lateral Stylet-Sacs*—poches styligènes, QUATREF., Taschen, KEF., &c.

* *Op. cit.*

(*v*, Plate IX. fig. 3)—occupy the exterior portion (covered only by the elastic coat and external longitudinal fibres) of the somewhat solid wall of the section immediately succeeding the foregoing cavity, and in some views cause a distinct bulging. 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 when the worm has been killed and hardened in alcohol, their long diameter is often found to be transverse (Plate V. fig. 5). Each sac is somewhat ovoid in outline, has a thin, transparent, contractile investment (sufficiently tough to prevent the points of the stylets piercing it during the motion of the worm), which lies immediately under the superficial layers of the section, and a duct passing from its central region to communicate with the pit of the anterior chamber of the proboscis. The direction of this duct under ordinary circumstances (*i.e.* when the animal is viewed from above as a transparent object) is forwards and inwards, but, like other structures pertaining to this mobile organ, it is liable to many alterations, and is occasionally much stretched and attenuated. It is also slightly narrowed on approaching the sac, and has at its junction therewith a series of protecting fibres (Plate VI. fig. 9, *a*). MM. DE QUATREFAGES and MAX SCHULTZE do not notice the duct at all, and M. CLAPARÈDE's figure* shows it distorted from pressure in *Tetrastemma*, but M. 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 fluid. The relations of the sac and its contents are shown in the various figures. In *Tetrastemma algæ* I have seen, besides the ordinary stylets, a group of minute crystalline spinets, which had no connection with the clear vesicle of the sac. The stylets very much resemble a lath-nail, and are formed of a translucent calcareous secretion; indeed, they appear like spikes of the purest glass. The head is bulged, rounded at the edges, and somewhat flattened on the top, from which an elongated conical spike proceeds to a sharp apex. 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 spikes, there are some with heads not fully developed, but complete in other respects; others again present the form of simple spikes of various lengths devoid of any head. In some instances the centre both of the head and point of the stylet is granular, while the superficial portion is of the usual homogeneous aspect. These stylets are secreted by the sac, yet I do not think they are *always* developed originally in one of the contained globules, as Dr SCHULTZE says; and this would not signify much, since the entire cavity must

* Recherches Anat. sur les Annélides, &c. plate v. fig. 6.

act as a secreting chamber, else the large ones could receive no increase after they had outgrown the capacities of the globules. 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, where they have assumed a stratified or laminated appearance. Sometimes a process (Plate IV. fig. 10), probably a remnant of the globule, passes from the head down the shaft of the spike for a short distance, as indicated by Dr SCHULTZE in *Tetrastemma*,* though seldom to such an extent in the adult stylet. The knob on the head 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 strong liquor potassæ.

In a large animal an interesting arrangement of the stylet-sacs occurred on one side, for there were two of nearly equal size, which communicated 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 had 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 fully 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 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. The stylets in the outer sac were quite as large as the central stylet. Thus at present, though I have often seen spikes inside, and connected with the fluid vesicles, I cannot support Dr SCHULTZE'S notion that the spikes *must* be developed therein. M. CLAPARÈDE says he has never seen the spikes inside those vesicles,† but I observe, in a more recent publication,‡ he figures a developing stylet in a globule in *Prosorhochmus Claparèdii*.

In a specimen that had often been under the microscope, I found on one occasion a pair of stylets, apparently from the lateral sac of one side, advanced nearly to the ganglionic portion of the proboscis. One lateral pouch, as it

* Beiträge zur Naturges der Turb. tab. vi. fig. 10, *a*.
† Recherches Anat., &c. p. 79.
‡ Beobachtungen über Anat. und Entwicklung, &c., 1863.

happened, was thus emptied, while the other retained its three stylets. The loose stylets were very slowly moved forwards, scarcely any progress being made during an hour's observation. At this time the sac from which they had been liberated 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 larger one. The former has assumed the shape of a stylet without a head; the latter is as yet nearly cylindrical (Plate VI. fig. 4). Whatever the function of these stylets in the lateral 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.

The middle or stylet-region is likewise the seat of other structures of importance, viz., the *central stylet and its basal sac*, the *ejaculatory duct* or canal of communication with the reservoir, and the *circlet of granular glands*. It is of the same vitreous translucency posteriorly as the succeeding region, while both the anterior chamber and the posterior region are of an opaque white in the fresh specimen. Externally there is the investing layer (Plate IX. fig. 3, *g*), continued from the anterior chamber, and which passes backwards to the next region. Beneath this lies a series of very powerful and conspicuous longitudinal muscular fibres (*f*, same plate), apparently to some extent continuous with the more bulky longitudinal layer of the preceding region, but few of which pass on to the next. Internally oblique and radiating fibres occur, the former slanting forwards and outwards from the setting of the central stylet, and forming a kind of muscular sling, well marked in *O. melanocephala* (Plate VI. fig. 7). This layer is distinctly separated at its posterior border from the succeeding region or reservoir by a pale boundary-line under pressure, so that the parts have a somewhat jointed appearance. In transverse section, the complicated structure of this part is well observed (Plate V. fig. 5). The longitudinal fibres form a thick belt exteriorly, and send gradually diminishing bundles inwards towards the central point. This peculiar appearance in transverse section must be due to some difference in the arrangement of the ultimate fibres, as such sections of other muscles usually show a much coarser, more fasciculated, and less granular aspect. There can be no mistake as to the true structure and arrangement of these fibres, since I have cut them both obliquely and transversely in the same specimen. The last-mentioned transverse section also shows a complicated arrangement round the central stylet-apparatus; exteriorly there is a firm setting, next a layer which seems to be closely united with the coat of the ejaculatory duct in front, and other two more immediately connected with the granular sac itself. Some of these appearances may have been due to the action of the chemicals in mounting, but they were very distinct. The ejaculatory duct has a single ring or coat surrounding it. The exact arrangement of the fibres of this region is difficult to unravel, but some evidently curve across the region, while those at the sides bend backwards, the latter in some views simulating the walls of a cavity. In *Tetrastemma vermiculus* (as a living transparent object) the region has its deep mass formed of fibres which curve outwards and forwards from the central setting (Plate IX. fig. 12). Through this 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 aperture of the duct μ') is generally obscured by the central stylet-apparatus, 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 minutely granular fluid passing onwards to the anterior chamber; and when the ejaculatory duct is not obscured by the glands, the dancing granules of this peculiar fluid are seen therein. Moreover, when the large compound cells (Plate V. fig. 3) have been detached under pressure, and squeezed forwards into the reservoir and along the duct, the calibre of the opening into the muscular sac may be ascertained with tolerable accuracy, and, so far as I could see, is such that only a single file of cells at a time can be transmitted. The duct has a bent-conical form, a shape that avoids interference with the basal sac 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, but I have rarely met with the organ in this position. In the latter state the inner or convex side of the duct is glandular, while the outer or concave side is not. A layer of longitudinal fibres, continued from the reservoir posteriorly, constitutes the proper wall of the tube, and is represented in transverse section in Plate V. fig. 3. Internally the tube has a mucous lining, which anteriorly is for the most part quite free from glandular papillæ; a few small glands, however, are generally observed towards its posterior end. Its wall 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, so as to be marked by a mere central streak (Plate XII. fig. 9, μ). The villous lining of the reservoir is often pushed forwards along the duct during violent contractions. 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, various figures) 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.

The cavity or *reservoir* (ϱ, Plate IX. fig. 3, and other figures), from which the 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 chamber. 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 having minutely granular contents (Plate IX. fig. 3, σ), and easily distinguished from those of the anterior chamber or long posterior gland. Towards the opening of the ejaculatory duct the glands are smaller than in the swollen part of the reservoir, and they again decrease in size before the organ narrows to its posterior channel of communication. In this comparatively large chamber the dancing granules, hereafter to be described, have free scope for the display of their movements, and not only do they move themselves, but they cause such large bodies 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 long glandular posterior chamber, the whole forming an hour-glass contraction, as represented in the various figures.

Before, however, proceeding with the description of the posterior chamber, it may be as well to complete the narration of the structure of the two translucent regions in which the foregoing duct and cavity lie.

In addition to the ejaculatory duct of the reservoir, the anterior division possesses also the central stylet and its peculiar arrangements, with the external circlet of granular glands. The former projects straight forward in the usual state of the parts, and is generally about the same size as the largest stylet in the lateral pouches, with which it likewise agrees in structure and composition (Plate IX. fig. 3, &c.). Its point under examination seems generally to project into the pit of the anterior chamber, though the thick muscular floor occasionally closes round it. The base of the stylet is fixed to the granular sac (λ); the arrangement being not inaptly likened by Dr JOHNSTON to an awl, the anterior or smaller end of the sac sending its investing substance over the head of the stylet, and grasping part of the spike. The basal sac (or awl-handle) is narrowed anteriorly, gradually widens backwards, is then marked by a constriction, and again is terminated by a wider 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 algæ*. The entire sac is opaque white, and coarsely granular from an early age, the granules disappearing with effervescence under the action of weak acetic acid, and rendered paler (in some cases dissolved) by liquor potassæ. These granules would not seem to be simply inclosed 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 when the anterior part is cast off with the stylet, as will be hereafter described. I have also seen the stylet and its granular basal sac thrown off together in a discarded proboscis in the proboscidian chamber of *O. melanocephala* and other species. This peculiar body or sac is set in a firm wedge of translucent yet compact muscular substance (marked θ in the various figures) which often has its posterior border curved in a saddle-shaped manner, projecting backwards in the middle, and with a curve on each side directed forwards. The anterior part of this wedge proceeds about as far forwards as the shoulder of the first swelling of the awl-handle, and there becomes lost on the coat of the latter. Though this generally appears like a wedge of translucent and structureless cartilage, the addition of liquor potassæ and acetic acid shows distinct striæ, chiefly of a transverse character when viewed under pressure, and therefore of a radiating nature with regard to the central granular sac. In front of the wedge-shaped division lies the muscular cavity (ϵ, Plate IX. fig. 3), into which the ejaculatory duct opens (at μ'). This cavity is formed by the knuckling outwards of the floor of the anterior chamber all round, and it is furnished with a distinct inner muscular coat. The walls are thus very mobile, and I have seen them form an hourglass 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 projected to the tip of the central stylet; while in the extruded state of the parts (ϵ, Plate VI. fig. 2) it forms, when seen from above, a compressed process at each side of the basal sac 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 basal sac. 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. Prof. KEFERSTEIN's anatomy of the region also requires correction, since he does not distinguish the separation between this cavity and the floor of the anterior chamber; thus in his representation* of the extruded proboscis, the central stylet projects smoothly into the water, and the ejaculatory duct opens directly into the latter at a short distance from the stylet.

* *Op. cit.* tab. v. fig. 3.

A very interesting condition was found in two specimens of *Tetrastemma varicolor*, which directly bears on the physiology of this region. In each a fragment of the granular sac, 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 instances the central stylet-apparatus was complete, only in one the anterior part of the basal sac appeared paler, and there was a slight irregularity in its outline, similar to that in fig. 14, Plate V. In each, the lateral stylet-sacs had their full complement of stylets, one or two of which equalled the central stylet in size. There appears to be only one explanation of this state of matters, viz., the fact 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, and it is still less likely to have been driven in by an enemy. Former experience in regard to the stylets from the lateral sacs 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 structure of the parts in *O. pulchra* will by-and-by throw still farther light on this subject.

Lastly, across this region passes the belt of granular glands (π, various figures), which have the form of lobules, with their long axes parallel to that of the proboscis, and are situated beneath the two external layers of the part. The granules are proportionally larger in *Tetrastemma.* I have not found any structural guide to their function, though they are invariably present in the Ommatopleans. A curious appearance was noticed in a small specimen of *Tetrastemma varicolor*, which had its stylet-region in front of the granular glands covered by an external coating of large cells, with a nucleus and faintly granular contents; such, however, may have been due to an abnormality.

The structure of the next division—that of the great Reservoir—has now to be examined (ϱ, Plate IX. fig. 3). On reaching the point previously mentioned (*a*, Plate IX. fig. 11), the elastic coat and the external longitudinal muscular fibres of the proboscis for the most part cease. Before this occurs, however, the muscular fibres (τ) peculiar to the region arise, sweep backwards in a beautiful fan-like manner over the reservoir, loop 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 felted aspect is produced under examination in some species, such as *O. purpurea* and *O. alba* (Plate IX. fig. 11), and is doubtless present in all. In addition, there are circular and longitudinal fibres within the former, and to whose presence the independent wrinkles of the inner structures are due. The longitudinal layer (*το*) 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 spread out to cover the dilated cavity of the reservoir, then become 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 a crossed or spiral aspect in the channel of communication; 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. By the contraction of these various fibres, the chamber of the reservoir 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, the entire region is much shortened, and the mass of the looping muscle increased posteriorly. Not only does the peculiar looping of the fibres cause most powerful squeezing of the cavity, but the posterior aperture has a tendency to be closed, and slightly carried forwards, the anterior being less subject to interference. The closing of the posterior aperture (channel of communication) is also greatly assisted by the circular fibres which are situated outside the longitudinal. The varying conditions of the reservoir may be understood by comparing Plate IX. fig. 3 with Plate XII. fig. 9, the former showing the organ in its ordinary state, the latter in a somewhat contracted condition.

The peculiar looping of the fibres of the reservoir causes a transverse section through its posterior part (Plate IX. fig. 10) to assume a finely radiated spiral arrangement, the whole reminding one strongly 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. Professor KEFERSTEIN describes only oblique and longitudinal muscular fibres in this region.

Posterior Region.—Behind the translucent region just described, the opaque white long posterior chamber (C) (*intestin*, QUATREF., *Drusentheils* of the Germans) occurs. It communicates with the reservoir in front, as previously mentioned, 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 chamber in length, the simpler structure of its walls giving 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 this lies a series of powerful circular muscular fibres, which towards the tapering posterior end become indistinct, and finally disappear altogether, after the cæcal tip is reached (Plate VII. fig. 4). The next coat is formed of an equally strong series of longitudinal fibres, the anterior or primary ones being continuous with the longitudinal layer of the reservoir, as previously mentioned. These run throughout the entire length of the posterior chamber, becoming proportionally more developed as the central cavity diminishes towards the cæcal end, and finally merging into the muscular ribands which terminate the organ. The mucous layer with its glands lies within the latter, 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. This mucous layer in contraction of the organ forms many rounded folds, which are especially distinct in *O. gracilis* (Plate IX. fig. 16). A transverse section of the chamber is represented in Plate IX. fig. 14, and the great increase of the glandular mucous layer in contraction is conspicuous. The two muscular coats are about equal in thickness. From the commencement of the region behind the translucent reservoir almost, but not quite, to its cæcal tip, its entire inner surface is covered with a series of glandular papillæ, which differ materially in structure from those of the previous regions. Viewed as a transparent object under moderate pressure (Plate V. fig. 9), the field is found to be covered with globular glands containing clear rounded vesicles in their interior. In contraction, and when the wall is less compressed, the glands have an enlarged and coarse appearance, only the external wall of each being visible. When the pressure has been increased, these glands, especially towards the posterior end (where, from their lessened numbers, a clearer view can be obtained), alter their shape apparently by bursting (fig. 10, same plate), and seem like a double ring of a minutely hirsute aspect, 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 have the appearance shown in fig. 8, same plate. The globules from the glandular papillæ (fig. 3) and glands whose contents have been evacuated (and which are minutely hirsute) readily pass forwards 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 remarkable fluid with the dancing granules previously alluded to. This secretion is produced in considerable quantities, and towards the posterior portion frequently distends the organ into a translucent pouch (Plate VII. fig. 4, *a*), wherein the moving 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 moving bodies appear as mere specks or points, and they retain this remarkable motion for upwards of twenty-four hours after extrusion from the cavity into the surrounding salt water. There is thus a peculiar fluid rich in these granules secreted by the posterior chamber or gland; and continued observation, and the whole anatomy of the parts, show that this fluid passes forwards 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 chamber, or when discharged into the surrounding medium in the extruded state of the parts, may be, can only be conjectured at present; but from the elaborate structure of the parts 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 might reasonably be supposed to affect them injuriously when discharged into the water around them. Whether the fluid has any influence on the secretion of the stylets in the lateral sacs, or in the central apparatus, I am unable to say; but, as already mentioned, a minutely granular fluid has been seen in the former, and a large though imperfect stylet in the posterior chamber of *O. pulchra*. MM. DE QUATREFAGES, VAN BENEDEN, and others, state that the proboscis and the foregoing apparatus are used in attacking prey; but, we may ask, Do the Borlasians use their feeble and unarmed structure for the same purpose? So far as I have seen, the proboscis is a somewhat precarious aggressive weapon, since it frequently adheres to the attacking body, and is thrown off. It is true we may assign, with an air of probability, an aggressive function to the central stylet; but we cannot do so with the very same organs in the lateral sacs; for, being developed in a free condition within almost closed cavities, they are quite useless as offensive weapons.

In extrusion of the proboscis (Plate VI. fig. 2), the entire spike of the stylet projects, the floor of the anterior chamber forms all round a thick and powerful umbrella-shaped cushion (whose independent structure has escaped Prof. KEFERSTEIN), the lateral 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 sac of the central stylet, has already been mentioned. The separation between the longitudinal fibres of the stylet-region proper (ν) and the looping fibres (τ) of the reservoir is well marked in this condition. It will also be observed that the stylet-region is widened by the forcible wedging forwards of the reservoir.

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, fig. 4, Plate VIII.), and which are attached to the walls of 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, now shortening more gradually—the curves being thickened here and there by the bulging of the fibrillæ. They are simply muscular fasciculi, with very fine longitudinal lines—the marks of the fibrillæ, and 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 a young *Tetrastemma variegatum*, in which the riband had been ruptured from its attachment, the fibres (Plate VI. fig. 6, ψ) had assumed a clavate aspect from contraction, and only very faint longitudinal markings were visible.

Before reviewing the statements of previous investigators with regard to the general structure of the foregoing parts, a description of the peculiarities of the regions in other species of Ommatoplea will be narrated.

In *Ommatoplea melanocephala* (JOHNST.), the proboscis is somewhat larger in proportion than in *O. alba;* and, while the type of structure is adhered to, there are several important differences in detail. The stylet-region (Plate VI. fig. 7) is peculiar in having the lateral stylet-sacs carried considerably forwards, so that they lie quite in front of the central apparatus, and the floor of the anterior region has consequently to form a deep pit to reach the spike of the stylet. In this figure the organ is shown comparatively free from pressure, and the encroachments of the lateral sacs on the cavity may thus be correctly estimated. The basal sac of the central stylet is proportionally large, while its wedge-shaped setting is comparatively meagre. The powerful series of oblique or radiating fibres which pass outwards and forwards from the latter, in the usual position of the organ under pressure, are very distinctly shown, and, as it appears, sling the apparatus. The points of the stylets (central and lateral) are rather blunt, and their shape, on the whole, resembles that found in *Tetrastemma algæ.* Some of the looped muscular fibres of the reservoir seemed to pass inwards beyond the exterior ring in front, so that a continuous series of fibres would thus be formed, as in certain viscera* (bladder, &c.) of the higher animals, and the chamber environed with the exception of the anterior and posterior openings. The circlet of granular glands is much developed in this species, 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

* Vide the admirable Researches of Dr PETTIGREW, *Philos. Trans.* part ii. 1867.

† Recherches Anat. &c. p. 166.

he has met with to the uniform arrangement of the stylet-apparatus, as, in addition to the forward position of the lateral stylet-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 lateral 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 a very pretty new species—dredged in Lochmaddy—of a salmon hue, striped down the back with two brown and a white central streak, having also a transverse brown bar at the posterior part of the head, and only two eyes,† the stylets were similar in shape to those of *O. melanocephala*, but decidedly smaller.

This shows that while distinctions in size and shape are valuable specifically, they should not be too much relied on.

The anterior chamber in *O. gracilis* (Plate VII. fig. 1) is very short in proportion to the great elongation of the animal, the stylet-region being found only a short distance behind the ganglia; indeed, in this respect, it is not far removed from *Polia involuta*, VAN BENEDEN. The floor of the anterior chamber has generally a bilobed aspect under examination, and hence differs considerably from that of *O. alba*. On each side of the floor in front of the stylet-sacs the end of the proboscis has not the massive muscular structure usually found in this position, but internally has a somewhat opaque mobile lobulated glandular arrangement, which, when the organ is everted, projects as two semi-opaque whitish papillæ (one on each side), the stylet-sacs being sometimes prolapsed into their interior. The central stylet and its apparatus do not easily project in this condition. The stylet-region proper, consisting of that part from the floor of the anterior chamber to the border of the reservoir, 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 an opaque granular mass on each side of the ejaculatory duct, sometimes entirely filling up the angle (at *a*, same fig.), and consist of a dense grouping of minute clear granules, and occasionally coarser particles in lobulated glands, which are apparently homologous with the granular glands of other species. The lateral stylet-sacs have very long ducts, and each encloses from seven to ten stylets of a characteristic shape, besides other contents. The central stylet is appended to a basal sac of great length, the sac indeed resembling the outline of some long bone, such as the radius, the stylet being articulated to the head, while the distal extremity of the bone is represented by the swollen posterior end of the sac. The latter has

* *Op. cit.* pl. xiii. *fig. 8.*

† The *Nareda superba* of STIMPSON has likewise two eyes, but has no longitudinal stripes.—*Synopsis Mar. Invert.* of G. MANAN, N. Brunswick, p. 28, fig. 17, 1853.

the usual granular contents, but the exterior firm setting, so characteristically wedge-shaped in other species, does not proceed half-way forwards, the slender anterior portion having only a thin covering for its support, as indicated in the figure. While in ordinary views the stylet and sac seem straight, both have a decided curve when seen laterally (Plate VI. fig. 12). Just in front of the point where the clear setting of the sac becomes indistinct, the ejaculatory duct opens into the peculiarly elongated muscular cavity (ϵ), which extends forwards to the circular opening in the floor of the anterior chamber. This channel shows a distinct inner layer of longitudinal fibres, which, however, seem to act only in company with the external oblique fibres surrounding them. The presence of this special inner coat demonstrates that it is not the mere doubling of the floor of the anterior chamber that forms this cavity, as indeed certain appearances, previously observed, had led me to suspect. The central and lateral 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 VI. fig. 13), 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 lateral stylets show a small secondary swelling or ring above the head (Plate VII. fig. 9). The ejaculatory duct is comparatively large and boldly marked, comprising at its posterior end almost the entire region of the reservoir, a slight demarcation, however, marking off the dilated posterior end into a portion pertaining to the reservoir, and another to the duct. The widened posterior end is covered with small glands, which are continued along the tube to its opening into the long muscular chamber behind the floor. One peculiarity in the elongated reservoir is the comparative thinness of the looped fibres towards the anterior end, 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 continuation of the cavity of the reservoir into it. The bulk of the looped 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 the posterior channel of communication is long. The external layer, continued from the preceding division, passes about half-way backwards over the reservoir. Another peculiarity is the presence of numerous clear cells and granules amongst the looped fibres, most distinctly seen at the posterior part of the chamber. Some of the cells contain nuclei, and 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 anterior is remarkable.

M. de Quatrefages seems to have devoted considerable attention to the anatomy of the foregoing species (his *Nemertes balmea*), and his deviations from accuracy, therefore, surprise us. He represents* the stylet-region as having the lateral sacs placed rather behind the long central granular sac, each of the former having 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 angle (at *a*, fig. 1, Plate VII.), previously described. His description of the contents of the lateral 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 sac attached to its extremity is very wide of the correct account. The outline of the stylets given by this author is inaccurate, since no constriction is represented in front of the head, and no mention is made of their curvature. The other objections to his views are noticed elsewhere.

The proboscis in the long purple species, *O. purpurea*, while approaching that of *O. gracilis* in slenderness and in tenuity of the posterior region, is yet more closely allied to *O. alba* in the structure of its comparatively short stylet-region proper. The floor of the anterior chamber in this species is furnished with very minute glands. Notwithstanding the great length of the worm, there is no corresponding elongation of the stylets, and the granular basal sac of the central apparatus is likewise short (λ, fig. 2, Plate VII.) The lateral stylet-sacs are small, and somewhat rounded, and their ducts are sometimes spindle-shaped, from marked constrictions situated respectively at the sac and opening into the floor of the anterior chamber. The stylets are at once distinguished by their short, stout form and peculiar longitudinal markings, which resemble the longitudinal streaks in polished mahogany (Plate V. fig. 12), and are due to irregularities in the outline. The granular sac of the central stylet (Plate V. fig. 13, λ) has only a slight constriction in the middle, so that the lateral line, from the apex of the spike to the base of the sac, is nearly straight. The opening of the ejaculatory duct into the cavity behind the floor of the anterior chamber is wide. The reservoir is much elongated, and it may be observed that its fibres, as pressed between glasses, are not seen in a looping series down the sides of the cavity, but form a densely felted arrangement on each side. When freed from pressure these fibres are observed to cover the reservoir with most elaborate crossings, from the diverse directions which they pursue. In the same region the longitudinal fibres are much developed anteriorly, though they are only well seen on stretching the parts, otherwise the felted arrangement of the looping fibres obscures them. The glands of the reservoir are smaller and less distinct than in *O. gracilis*, especially anteriorly. The channel

* *Op. cit.* pl. x. fig. 8.

† "Quelquefois, surtout chez le *Némerte balmée*, on aperçoit même un commencement de la tige du stylet."—*Op. cit.* p. 166.

of communication with the posterior chamber is somewhat short and wide, and in marked contrast with the same part in the latter form. The long posterior chamber has its inner surface thrown into more prominent rugæ than in most species, so that they sometimes appear like large papillæ covered with the glands-proper of the cavity. These plaits are not mere wrinkles and folds caused by the contraction of the elongated organ, but are present under severe pressure; indeed, they are characteristic and original processes of the chamber (Plate IX. fig. 16). The granules of the peculiar fluid therein are also very distinct. It may be mentioned here, 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 lateral 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 Claparèdii* undergo a like degeneration. In a specimen of the former species where this had occurred, the wave of granular fluid driven forward by the contraction of the reservoir distended the muscular cavity in front of the granular basal sac of the central 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 sac, and distended it and its wedge-shaped setting with every impulse. The absence of proper nutriment and free aeration—for the salt water was but rarely changed during the year—are sufficient causes for the above-mentioned degeneration.

In *O. pulchra* (JOHNST.) the anterior region of the proboscis has a decidedly pinkish hue, and numerous small clear globules at its commencement, as well as over the reservoir. The large glandular papillæ in the anterior chamber have their marginal globules less distinctly marked than in *O. alba* or *Tetrastemma*, and hence the structure has a smoother or finer appearance. The lateral stylet-sacs (Plate VII. fig. 3, ν) are very large, 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 from the long posterior chamber. It is, however, in the apparatus of the central stylet that the greatest deviation from the typical structure occurs. The basal sac of the stylet (Plate VI. fig. 11, λ) is small, elliptical rather than ovoid, and its granules are very minute. In addition to the ordinary stylet (*a*) fixed to its anterior end, another stylet (*b*) projects into its posterior portion, enclosed in a kind of sheath, and whose point extends forwards 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 progenitor for complete development. The head of the reserve-stylet projects into a large cavity formed by a peculiar disposition of the fibres composing the setting of the basal sac and the region behind. Instead of the usual wedge-shaped structure, radiating fibres pass outwards from the sides of the sac, curve backwards, and arch over a large cavity (Plate VII. fig. 3, *o v*) filled with a clear fluid, part of the floor being formed by the anterior fibres of the reservoir. In certain states of contraction the central (reserve) stylet may be seen pressed backwards, so that its butt rests on the latter—a position quite easily attained on account of the yielding nature of the cavity and tissues which lie immediately behind and around it. Some granular streaks, probably due to the granular glands, are also observed passing from the central sac along the arch of the fibres. The granular glands themselves are distinct enough if the specimen is not too much pressed. The peculiar cavity behind the central granular sac 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 sac in *O. alba,* and others, where no such space exists. Physiologically the cavity may also act as an elastic buffer or cushion when the stylet is driven into any structure, if such ever occurs. The ejaculatory duct is large, and being surrounded by a yielding region, is more mobile than in the typical forms. The clear globules interspersed amongst the looped fibres of the reservoir are numerous, so that under pressure the cavity seems covered with them; and if pressure is severe, they escape into the reservoir, and pass forwards into the ejaculatory duct. Posteriorly these looped fibres have a laminated appearance. During examination the walls of the reservoir were frequently contracted in the manner shown in the drawing (Plate VII. fig. 3), thus indicating very clearly the presence of circular fibres. The entire region had more translucent walls and greater mobility than in *O. alba*, and the coats were somewhat diminished in total bulk posteriorly, so that the channel of communication was short. The glands are large transparent structures, with clear globules in their interior, and in general aspect differ from any hitherto observed. Those of the posterior chamber of the organ were longer than in *O. alba* and *Tetrastemma.* In one specimen several stylets lay in the *cul-de-sac* of the latter chamber, showing that they had passed along the ejaculatory duct, or else had been formed in the cavity.

The muscular and other structures of the anterior region of the proboscis of *O. pulchra* present, in transverse section, a slight variation from the common type, as seen in *O. alba.* The beaded layer (Plate VII. fig. 10, *e*) is very distinctly marked, and the external angle of the somewhat lozenge-shaped enlargements (longitudinal bands) is connected with the outer layer (*g*), while a process from the opposite angle passes inwards towards the circular coat (*c*), so as to cut the great longitudinal layer (*d*) into a number of separate fascicles, which, in the specimen represented, amount to fourteen. The changes which ensue in the various layers, when the organ is completely everted, are portrayed in the figure; and the characteristic appearance of the beaded layer (*e*) is to be noted, as well as the swollen segments of the usually thin external longitudinal layer (*f*).

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 at all to the remarkable 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.

The general arrangement of the proboscis in *Tetrastemma algæ* agrees with that in *O. alba*, though there are some minor differences in the details of the stylet-region. If under examination the ejaculatory duct is placed on the left of the central stylet-apparatus, 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. algæ*). The central stylet and its sac 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 side (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 this line, while the curved or radiating fibres are rendered more distinct. On the left side the only boundary line to the supposed distinct coat around the wedge-shaped setting is the wall of the ejaculatory duct. The basal sac of the central stylet in *T. algæ* (to continue the description) has rather more shape than in *O. melanocephala*, and is proportionally more elongated. I thought I could detect a slight difference between this species and *T. variegatum*, for the stylet in *T. algæ* is generally shorter in proportion to the length of the sac than in *T. variegatum*. Considerable variations exist in the size of the several stylets in *T. algæ*, independently of the size of the animal, a fact, perhaps, the less to be wondered at when the reproduction of the tube is remembered; but the greater size is generally diagnostic when compared with other species. In a developing or recently repaired central apparatus (Plate V. fig. 14) the basal sac is thinned off anteriorly from contraction of the parietes, and the difference in size between this central stylet and one from the lateral stylet-sac (Plate V. fig. 15) of the same animal is marked. In *Tetrastemma variegatum* the structure of the stylet-region, while agreeing generally with *O. alba*, is yet more particularly allied to *T. algæ*. The stylets are on the whole more slender than in the latter, and the central longer in proportion to its basal sac. In *T. vermiculus* the structure is similar to the two former (Plate IX. fig. 12). The shape of the basal sac of the central apparatus in *T. varicolor* is characteristic (Plate VI. fig. 5), the stylet being more slender than in the other two species, larger in proportion to the sac, and the lateral lines of the latter nearly straight. The proportionally large size of the glands in the

* Catalogue of Worms, &c. p. 292. † Mag. Zool. and Bot. vol. i. p. 531, fig. 4.
‡ Recherches Anat. sur les Annel. Turb., &c. p. 81, plate v. fig. 6.

reservoir in *Tetrastemma* is well illustrated in this species, where they form very prominent structures with granular contents, and more nearly allied to those in the posterior chamber than in *O. alba*. In transverse section the microscopic structure of the organ in the foregoing species agrees with that in Ommatoplea.

In *Polia involuta*, VAN BENEDEN, the proboscis and its apparatus are reduced to a minimum. The anterior region (Plate VII. fig. 5, A) is very short, and has in general a somewhat conical outline, the base of the cone being formed by the floor of the chamber. Its walls are proportionally thick and muscular, and internally have a minutely granular aspect, 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 next, or stylet-region proper, while still retaining the Ommatoplean type, differs much from that of any other British species. Instead of the usual well-defined arrangement of longitudinal and radiating fibres, the entire muscular structure is obscured by numerous granular or cellulo-granular bodies (γ), which give a characteristic appearance to the somewhat conical region. There is no trace of lateral stylet-sacs. The central stylet is minute, and furnished with an elongated and faintly granular basal sac, which is fixed in the usual transparent muscular setting, the mobile muscular chamber into which the ejaculatory duct opens being situated immediately in front. Though the whole apparatus is very minute, I have seen the stylet thrust forwards by the contraction of the fibres of its basal setting, so that its point projected into the floor of the anterior chamber of the proboscis. The ejaculatory duct is large, and, owing to 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 being, renders the denser granular masses at the sides more conspicuous. The region of the reservoir is fairly developed, the walls being striated with transparent muscular fibres in the usual manner, and the granular glands lining the inner surface. The walls might be seen now and then contracting with force, and driving the contents forwards into the ejaculatory duct and muscular chamber behind the floor of the first region. The posterior channel of the reservoir led into a posterior chamber of comparatively small dimensions, but having thicker walls than usually found in this region, and terminating in a *cul-de-sac* and rounded end, a short distance behind the œsophageal apparatus. This chamber had a cellulo-granular lining internally, and in some specimens the posterior end was observed under pressure to be distended with a transparent fluid containing a few compound cells of similar aspect to those found in other species. This posterior region is kept in position by fibres from the strong bands at the posterior part of the œsophageal apparatus.

All that M. VAN BENEDEN says with regard to the structure of this organ is that it is very short, and bears an "isolated" stylet, while his enlarged drawing* is incomplete.

M. DE QUATREFAGES considered the *posterior chamber* of the Ommatoplean proboscis the intestine-proper, but there is no support for this view; and, indeed, his minute anatomy of the organ 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 bulgings 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 refer to 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 see any longitudinal fibres. I have always been able to see these fibres in the fresh and living animals without any addition to the sea-water in which they happened to float; and, moreover, the presence of longitudinal, looped, and other fibres previously described show how much more complex the structure is than this author imagined. He correctly reports the absence of vibratile cilia from this region; but he again errs by affirming that they occur in the posterior chamber. His figures of the stylets are different from any seen by me, since they exhibit a bulging and then a contraction in front of the head. The basal sac is termed the "body" of the central stylet, and he narrates how in *Nemertes balmea* (our *O. gracilis*) this body has an exterior coat composed of the same structure as the point. Nothing more than the usual firm muscular setting is really present (see p. 335). Again, the statement that the "body" acquires greater solidity is not borne out in fact, for the granular contents of the sac 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 sac (or so-called "body") is fixed in a clear setting 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

* Mémoires l'Acad. Roy. &c. pl. iii. fig 6.

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 any of the British species, and the opaque granular substance really present in *O. 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 this have probably caused the error—an opinion shared by Prof. KEFERSTEIN; 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 mistakes. 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 observation, that the lateral 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 a single lateral stylet-sac in *Polia quadrioculata* and *P. humilis* was accidental, and not by any means a characteristic of such species (*Tetrastemma*). I have also very little doubt that the presence of the toothed cartilaginous plate, which he describes as occupying the usual place of the central stylet in *Cerebratulus spectabilis*, has been due to some mistake or confusion in his notes. Indeed, the author himself 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 remark, that in *Polia vermiculus* one sac was 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. This 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." His distinguished countryman, M. MILNE EDWARDS,* is also in error in regard to both of these points. Lastly, M. DE QUATREFAGES is only certain of the muscularity of these ribands in *Polia coronata* (*O. melanocephala*), and he gives a curious figure (which cannot be verified in the British examples) of their termination in this species—as a series of arborescent fibres.

* Leçons sur la Physiol. et l'Anat. Comp. tome v. p. 464, 1859.

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, considered that the "intestine," as he termed the organ, proceeded to the tip of the body and terminated in a distinct anus.

Dr Williams† observes with regard to the proboscis (his alimentary organ), "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 furnished an important secretion for the digestive process, which secretion was exuded into the "œsophagus" (apparently, judging from his figure,‡ the proboscidian sheath), and thence into the great alimentary organ—rests upon no facts. He is also wrong 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 this, but confounds its structure with the wedge-shaped setting of the basal sac, the whole forming, he says, a quadrangular mass. He falls into the same error as M. de Quatrefages and others, in describing the terminal ribands of the organ as attached to the wall of the body. His figure|| of the exserted stylet-region is incomplete in detail, for he omitted to notice the ducts of the lateral stylet-sacs, though he regarded the latter as the producers of the

* Mag. of Zool. and Bot. vol. i. p. 530, 1837, copied into "Catalogue" Brit. Mus. pp. 285–6 1865.

† Report Brit. Assoc. 1851.

‡ *Op. cit.* pl. xi. fig. 64.

§ Beiträge zur Naturges der Turb. 1851, p. 62, tab. vi. figs. 2–10.

|| *Op. cit.* tab. vi. fig. 3.

stylets for the central organ. He first indicated, however, the connection between the developing spikes and the clear globules in the lateral sacs, showing that they are sometimes seen in their interior. Finally, he has not discriminated the structure of the reservoir-region, and its relation to the neighbouring parts; and, indeed, his anatomy of the animal, from the limited nature of his observations, is somewhat imperfect.

M. CLAPARÈDE,* in his remarks on *Tetrastemma varicolor*, describes the sac of the central stylet 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 evidently mistaken the translucent wedge-shaped setting of the sac for a cavity, and the triangular muscular structure shown exterior to this has no existence as figured (*vide* p. 339). He has correctly observed the presence of a duct to the lateral sac, though his figure is somewhat distorted from pressure, and represents the duct by far too wide. He is, moreover, of the opinion that these chambers are not for the sake of furnishing new stylets for the central organ, as Dr SCHULTZE avers, but for the lodgment of those discarded from the latter; a view quite as erroneous as the other. Each supplies its own stylets. He did not observe any connection between the clear globule in the lateral sacs and the developing spikes. His representation of the muscular fibres of the stylet-region is faulty. In mentioning the cavity of our reservoir, he properly describes the presence of a liquid containing minute granules in suspension (but not in motion), and that it (reservoir) communicates with the "trompe" by means of an efferent canal: but he fell into the error of regarding the long posterior chamber as a "muscle retracteur." His figure is inaccurate in other respects, such as in the mode of opening of the ejaculatory duct, and in the absence of the muscular space behind the stylet-aperture in the floor of the anterior chamber. He regards the reservoir as a poison-gland, which squirts its contents along the ejaculatory duct into the wounds inflicted by the stylet. This author is scarcely correct in saying that M. DE QUATREFAGES had in reality figured this poison-gland without the efferent canal in *Polia mandilla;* for the French naturalist figures and describes the part as one of the bulgings of his œsophagus, and which, therefore, communicated both with the "trompe" and "intestin." In a still more recent publication† M. CLAPARÈDE exhibits the structure of this region in KEFERSTEIN'S *Prosorhochmus Claparèdii*, a viviparous species, but he gives no details of muscular structure. The central stylet and its sac are placed in the middle of a continuous and apparently homogeneous oblong body, the wedge-shaped enclosure of the basal sac and the muscular cavity in front being confounded. The opening of the ejaculatory duct of his poison-gland (reservoir) has the same position as in his previous figure, viz., at some distance from the stylet, and passing directly

* Recherches Anat. sur les Annélides, Turb. &c. 1861, p. 81, pl. v. fig. 6.

† Beobach. über Anat. und Entwicklung. wirb. Thiere, &c. 1863, p. 23, tab. iv. fig. 10–12.

into the floor of the anterior chamber. He now refers to the posterior chamber, which, he says, occupies the centre of *the muscle of the organ*, a modified but scarcely satisfactory description. The external granular glands show certain peculiarities when contrasted with other species, viz., complete separation, large number and minute size of the divisions or lobules—modifications that I have not been able to verify.

M. VAN BENEDEN'S brief remark on the proboscis in *Polia involuta* has already been adverted to. It may also be stated, however, that, in addition to the incompleteness of his figure, he represents certain lines,* which indicate a sheath (one of his *culs-de-sac*) around the proboscis—a state that has not been seen in our examples. The structure of the stylet-region, as observed by him in *Polia obscura* (*Tetrastemma varicolor?*), is erroneous. He represents no ducts to the lateral stylet-sacs; no ejaculatory duct. The division of the reservoir has a cavity in the centre, but is likewise furnished with two hypothetical oval vesicles or cavities, and the muscular structure, the floor or ending of the anterior chamber, and other important points, are absent. The statement, that the lateral stylet-sacs contained stylets of a smaller size than the central, and of a different form at the base, shows the learned author did not possess good opportunities for examining these creatures. He follows Dr SCHULTZE in calling the lateral sacs pouches of replacement, and therefore is not aware of the true physiology of the parts. While he states 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 on the question, he again repeats the statement when drawing up his conclusions, by erroneously 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, as in the stomach of the *Bryozoa*.†

Prof. KEFERSTEIN'S‡ remarks, so far as they go, upon this region in *Polia mandilla*, are decidedly in advance of his predecessors. He, however, does not mention the *minute* glands on the floor of the anterior chamber, and shows the central aperture for the stylet in the same by far too large, so that in extrusion the muscular space (ϵ in our figures) becomes obliterated. The muscular setting of the granular sac is also continued too far forwards in his figure. He indicates no oblique fibres from the pit of the anterior region (as shown in Plate IX. fig. 3), and the thick coat of the reservoir is described as composed of longitudinal fibres. The external granular glands are not distinctly described; and the disproportion between the central and lateral stylets is so great, that I fear some

* Mém. de l'Acad. Roy. des Sc. de Belgique, tom. xxxii. pl. iii. fig. 7.

† *Op. cit.* p. 44. Unfortunately this author has not lettered his plates, so that I have often been at a loss as to his interpretation of structures of which no mention is made in the text.

‡ Zeitsch. für wiss. Zool. Bd. xii. p. 72, taf. v. fig. 4.

slip has occurred in their delineation. Lastly, his crenated border (external elastic coat) does not pass the constriction between the stylet-region and the reservoir-region, whereas, as already shown, both this and the longitudinal coat are continued some distance on the latter division.

Reproduction of Proboscis.—So far as I am aware, no author has alluded to the reproduction of this organ. The process was first observed in *Ommatoplea melanocephala*, but it has since been seen in *O. gracilis*, *Tetrastemma algæ*, and others. In a specimen of the former (*O. 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 had been made, and the organ proceeded backwards as a slender rod tapered posteriorly (Plate VIII. fig. 1, *a*). There was a distinct exterior coat from one end to the other, and an inner terminating at the commencement of the posterior narrow portion. The former had 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 of growth (Plate VIII. fig. 2), 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 its muscular fibres with those of the higher invertebrates, since it so much surpasses them in mobility. The floor of the anterior chamber ends in the usual pit, which is swollen 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 sac is represented by a somewhat triangular group of the usual granules, round which the radiating fibres are placed. The wedge-shaped setting within the latter (fibres) is mobile and translucent. A somewhat indistinct streak (*f*) in the central line indicates the canal for the central stylet, and now and then this became bulged by projected fluid. The lateral stylet-sacs, from the bulging of the chamber in this instance, seem pressed backwards, but in reality they have their distinctive position. Each contained a stylet or two, a few granules, and a clear globule.

The reservoir at this stage had assumed its characteristic shape, though its glands were barely visible. The shortening and bulging of the anterior and posterior chambers have annihilated the usual prominent appearance of this part, and the last has encroached very much on the cavity posteriorly. The glands were formed in the posterior chamber, though their contents were not elaborated, and the cavity terminated in the usual *cul-de-sac*. A few rounded papillæ at the posterior end indicated the early condition of the muscular retractor or 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 *O. gracilis*, a very good analysis of the somewhat complicated structure is obtained, so that doubtful anatomical points are cleared up satisfactorily. The sac at the base of the central stylet is sometimes seen to be composed of granules in rounded masses; and they are all grouped posteriorly at an early stage, and thus present a similar form to that seen in other species which have no such elongated sac 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 produces 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 lateral 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 of the Ommatopleans 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 the organ has been violently expelled) the cast-off proboscis; and it is a curious sight to observe a fully-developed organ 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 debris.

Digestive System.—Though no such 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 or sac, as first described by Sig. DELLE CHIAJE, apparently in a Borlasian.† The figures of the supposed transverse plate given by the former, indeed, show some degree of doubt, since in the large figure ‡ both wavy and longitudinal fibres are represented, while in the small figure there are only transverse fibres. I fear the wavy longitudinal lines owe their presence to those actually existing in the œsophageal sac. Dr JOHNSTON'S figure § of *O. melanocephala* indicates this structure, to which he thus

* Monograph of the British Spongiadæ, Ray Society, vol. i. p. 5, *et seq.*

† Mémorie sulla, &c. vol. ii. 1835.

‡ *Op. cit.* pl. xix. fig. 1, *m.*

§ *Op. cit.* pl. ii. *a* fig. 5.*

refers under the head of *O. pulchra*:—"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." Prof. 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 Borlasians. 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 with regard to his figure of *Prosorhochmus Claparèdii*, KEF.‡

In every specimen of *Ommatoplea* and *Tetrastemma* the great œsophageal organ above-mentioned has been easily observed (Plate VIII. fig. 3, *j*) as an elongated sac, slightly narrowed posteriorly, and usually thrown into various longitudinal wrinkles. In ordinary views from above, it is seen to narrow somewhat abruptly behind the ganglionic commissure, and to pass forwards beneath the inferior one, to open at the tip of the snout just at its ventral border, as a short longitudinal slit. I have seen the sac turned inside out here, and projecting beyond the head in an animal which had been subjected to chloroform. Both apertures may frequently be observed at once,—that for the proboscis being circular, while the mouth forms a short longitudinal slit beneath the former. The observations on this point have been often repeated, out of deference to the distinguished foreign authors who hold different views, but I have never seen any other aperture in the British Ommatopleans, and it were hard for such to exist in the free portion of the œsophageal tube behind the ganglia. Moreover, as shown in Plate IV. fig. 1, the narrow anterior part of the glandular œsophagus lies close to the chamber for the proboscis, when the latter is in this region. The two organs, proboscis and œsophagus, become more evidently separated from each other in most sections, just in front of the ganglia, and the interposition of the broad inferior commissure soon renders the distinction more evident; thereafter they have the tunnel of the proboscis as a partywall, together with that portion of the fibrous stroma 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 V. 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 generally translucent; and just behind the commissure a pursed arrangement is often seen, which is followed by the more opaque portion with its longitudinal rugæ. The pursed arrangement is very similar to that which is caused by tying the mouth of a

* *Op. cit.* p. 70.

† Mém. l'Acad. Belgique, pl. iv. fig. 13.

‡ Beobachtungen über, &c. pl. v. fig. 10. ph.

leathern bottle, and is due to the narrowing of the sac in front. The pale portion immediately behind the ganglia shows cilia in active motion very distinctly, but I have never seen anything like 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 during the motions of the animal under pressure, at once demonstrates the fallacy of supposing it connected with any post-ganglionic aperture, as in Borlasia. The wall of the sac evidently contains some contractile fibres, which cause it to dimple inwards here and there during its motions; and in anterior transverse sections the cut ends of longitudinal muscular fibres are shown very distinctly, though they are finer than those of the proboscis. Posteriorly, the organ opens into the digestive cavity; but the communication is not actually seen in ordinary views, from the folding together of the walls, and I have not been so fortunate as to observe the animals feeding. In *Polia involuta*, VAN BENEDEN, the œsophagus is short and nearly globular under moderate pressure, being also conspicuously tied posteriorly by strong transverse bands. In this species the posterior aperture is very apparent.

The relations of the œsophagus to surrounding organs may be observed in the sections (Plate IV. fig. 5, and Plate V. fig. 2, at *j*). The walls increase in thickness after passing the narrowed portion in front, form considerable parietes, and again slightly diminish posteriorly. In transverse sections of specimens hardened in spirit, and mounted in the usual manner, the structure has a streaked and fibrillated aspect, or 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 observed that in these sections the organ is thrown into numerous characteristic longitudinal folds. In life considerable differences in appearance are observed, according to the degree of pressure—as, for instance, between the flattened follicles of the organ in a small *Tetrastemma*, and the thicker structure in a good-sized *O. alba* (Plate VII. fig. 7). In the latter, the inner edge (*a*) of the glandular tube has a somewhat translucent and well-defined border, garnished with moderately long and most vigorous cilia, whose activity is in strong contrast with the motion of the same organs on the epidermis, and which seem to play an important part in the economy of the tube. Under the microscope the fresh specimen is always thrown into numerous wrinkles, and is crossed by pale streaks—the ciliated edges of the folds (*b*). The entire organ is studded internally with a series of granular glands or follicles, and numerous brownish pigment-granules. The glands taper towards the free ciliated edge of the rugæ.

In *O. melanocephala* the organ is curiously narrowed posteriorly; and in *O. pulchra* the granular glands are distinct and large. In *T. varicolor* the glandular appearance in a small specimen under pressure is somewhat finer and more translucent, but the structure is essentially the same as in *Ommatoplea*.

This ciliated glandular structure is physiologically and homologically an organ of great interest. It is entirely Ommatoplean in the condition just described, since what is shown here in the complete form is only indicated in *Borlasia* 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 *Ommatoplea* arise (in the case of the cells, at least) on the sides considerably in front of the posterior end of the œsophageal region—in some cases, indeed, almost touching the ganglia (Plate VIII. fig. 3), and besides, the first region has been demonstrated to occupy a special pouch in which it rolls. The rich ciliation of this œsophageal region, and the somewhat indistinct ciliary movements seen in the posterior division of the alimentary chamber, are points of importance when contrasted with the arrangement in *Borlasia*, and show that from structure to structure the essential differences between the groups meet the inquirer at every step. In *Vortex*, again, the homologue of this region is seen in the "Schlund" of the German authors.

The Digestive Cavity-Proper.—The detailed description of the general cavity of the worm (all within the muscles) given by M. DE QUATREFAGES, shows that he had no clear conception of this structure, for, after explaining the hypothetical transverse diaphragm, to which we have already alluded, he goes on to say,*— "Le reste de la cavité générale occupe tout le corps proprement dit; mais les cloisons verticales auxquelles sont suspendus les organes générateurs le partagent entrois 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 Prof. KEFERSTEIN has pointed out, the glandular wall of the digestive cavity. I am at a loss to understand how M. DE QUATREFAGES did not correct his error on contrasting his figures of the male and female elements in his *Nemertes balmea* (*O. gracilis*), for 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‡ recognised 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 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

* Op. cit. p. 152.

† Op. cit. e.g. pl. xviii. fig. 1, and pl. xix. fig. 1.

‡ Mag. Zool. and Bot. vol. i. p. 532.

§ Report Brit. Assoc. 1851, pp. 244–5.

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 says, act upon the exuded food, after its passage through the walls of the "œsophagus." He is correct in denying the ovarian character of the organ, and in showing that the so-called ova consisted only of oil-globules. He has also some reason for considering the transverse segmentation of the organ as an indication of annuli.* Dr MAX SCHULTZE† described it as a straight canal in *Tetrastemma obscurum*, ciliated on its inner surface, and opening anteriorly and posteriorly, and figures ‡ the cells in its walls as altered by extrusion into the water. M. CLAPARÈDE, in the before-mentioned figure of *Prosorhochmus*, shades the region, but makes no mention of it in his description.

The digestive cavity is a somewhat moniliform or lamellated canal, in so far as its surface is increased by the numerous diverticula. Its appearance under pressure is well seen in *Tetrastemma* (Plate VIII. fig. 3) as a lobulated glandular organ, usually of a pale flesh or slightly pinkish hue, extending from a short distance behind the ganglia to the tip of the tail, and forming (in the individual 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 ova 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 filled up 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 posterior end of the rugose œsophagus; posteriorly it terminates in an anal pore, less easily seen than the similar structure in *Borlasia*, from the absence of the strongly ciliated internal line. 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 a long time in doubt about the ciliation of this chamber in *Ommatoplea*, since I have seldom been able to see cilia satisfactorily in the uninjured *O. alba*, though in the latter, *O. purpurea*, *Tetrastemma*, and especially in *Polia involuta*, VAN BENEDEN, peculiar motions of the cells were apparent. When a specimen is kept for some time under pressure, a few moving granules are observed at some particular point; these continue to increase in number, and sometimes a few cells accompany them, the group gradually enlarging and

* Philos. Transact. 1858. † *Op. cit.* p. 64. ‡ *Op. cit.* taf. i. fig. 35.

revolving with great velocity. Such motions are doubtless due to the ciliation of the chamber. On making a transverse section of the living animal (*O. alba*), I have seen the inner margin of the digestive cavity cause motion in the surrounding particles, but the cilia were indistinct, and the appearances very different from the richly ciliated tube of *Borlasia*, or its own 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 as having some analogy with the liver of the higher forms, notwithstanding the adverse opinion of Prof. KEFERSTEIN, who, however, probably refers more particularly to the Borlasians. Microscopically the cells consist of a delicate membrane containing a number of fatty globules (Plate X. fig. 6), the average size of the cell being $\frac{1}{800}$th of an inch. Under pressure, and when highly magnified (700 diam.), it is seen to consist of a number of granular fatty bodies (Plate X. fig. 7). After extrusion from a living specimen into salt water, a remarkable motion occasionally ensues in the contents of the cell before breaking up, a condition which causes the observer to fancy the entire organ ciliated. The contained bodies jerk about within the cell, and soon a number of very minute granules appear, having burst from the larger bodies, in which their presence is indicated by obscure markings. The peculiar motions would seem to be due to the action of the water, and ultimately the minute contained bodies are all set free. The various appearances of the bodies from the cells are shown in Plate X. fig. 8, some being granular, others presenting faint concentric lines like starch-globules (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*, and often escape under pressure posteriorly. The quantity of deep yellow oil in this organ in *T. algæ* is unusually great. The foregoing glandular structure undergoes partial absorption at the period of reproductive activity, so that after spawning the animal is much flattened; but by-and-by it regains its plumpness, and often becomes of 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 *O. gracilis* the posterior division of the digestive system has a somewhat regularly ramified arrangement, when viewed from the ventral surface, and this is especially evident some time after spawning, when the animal has regained its condition. The colour of the region is of a deep green by transmitted light, whereas the œsophageal division is brownish. The lamellæ of this region in *O. pulchra* form simple tapering papillæ under pressure. In *Polia involuta*, V. BEN., 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.

In *O. alba* and *rosea* Mr E. RAY LANKESTER* found many Gregarinæ, but they were rare in the specimens from St Andrews. In *Tetrastemma varicolor* a few gregariniform parasites (Plate IV. fig. 12) occurred in the digestive cavity towards the tail.

Another parasitic structure was found in January in a large male specimen of *Ommatoplea alba* in the form of an ovum enveloped in a granular lobulated mass—lying close behind the ganglion of one side (Plate XIV. fig. 9, *y*), to the exterior of the proboscidian sheath, and altogether unconnected with the œsophagus. Externally there was a distinct hyaline capsule or cyst, to which certain fragments of the fibro-granular lobulated covering adhered. The embryo was furnished with a very conspicuous opaque granular mass, and two discs; while the general stroma was cellulo-granular, here and there closely streaked by minute lines, apparently from its external investment. No motion of the included animal was observable, except an alteration of the size and aspect of the pores and discs after a period of eight or nine hours. There was no doubt as to this being a Trematode-larva in its capsule, and by rupturing the latter a complete view of the embryo was obtained (Plate XIV. fig. 10). The oral sucker (*c*) was considerably smaller than the ventral (*b*), and this formed a marked feature in the general aspect of the animal. The œsophageal bulb (*d*) appears as a distinct swelling close behind the margin of the oral disc, and from the tube behind the former the alimentary cæca (*e*, *e*) branched off and became lost in the cellular tissues posteriorly. The opaque mass of cells and granules (at *a*) corresponded to those observed in the Trematode-larva of the *Carcinus mænas*,† though, from the immature condition of this example, these and other structures were much less definite. There were also two large circular granular bodies (generative organs) (*f* and *g*); but only a trace of the excretory tubes existed in front near the oral sucker.

Microscopically, the alimentary organ has scarcely the regular and firm glandular appearance of the same structure in Borlasia, 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. The large size of the proboscis in the Ommatopleans renders this system very obscure from the dorsal aspect, and it is only when the ventral surface is upturned that a correct know-

* Jour. Micros. Sc. 1865.

† Jour. Micros. Sc. vol. v. N. S., pl. viii. fig. 5, *k*.

ledge of its relations is obtained. I have not been able to see *O. alba* feed in captivity, and have not found any food in the alimentary cavities of those examined. It is a curious fact, that in this group the digestive system lies quite beneath the nervous system anteriorly, whereas the proboscis passes through the nervous collar.

Circulatory 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 great central trunk posteriorly (Plate VI. fig. 8, *p*) in *Ommatoplea*, 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 two last-mentioned, just within the posterior border of the worm. It travels forward beneath the proboscidian chamber in a very undulated manner—as usually seen—to the region behind the ganglionic commissures, where it bifurcates (Plate VI. fig. 3, *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 forwards into the tissues of the snout (*l*, same figure, and in Plate IV. fig. 6, the latter showing the vessels in transverse section), the pillars of the arch thus meeting the lateral and the anastomotic vessels of each side. From the same point of union each lateral trunk passes backwards under the nerve-cord of its side 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 vessels appear to diminish slightly posteriorily. 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 which intervenes 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 *O. purpurea* there are three main longitudinal trunks as in *O. alba;* but it can be observed that the lateral communicate with the central, as in Borlasia, by transverse branches, which, however, are proportionally smaller. Whether such anastomoses occur in the pale Ommatopleans is thus an open question; but they are distinct enough in this species. Two lateral trunks only could be discovered in *Polia involuta*, Van Beneden (Plate VIII. fig. 5, *r*), which trunks unite by a very short loop just in front of the commissures. This loop (*l*) is distinguished from the ordinary arrangement by its not extending forwards into the tissues of the snout. The lateral vessels are not so clear or well defined as in *O. alba* and *Tetrastemma*, and are observed to have internal transverse bands or partial septa in front; while the contained fluid has a few clear granules, as in *O. purpurea* and others. The contractions in the lateral vessels 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 I can see, is as follows:—Posteriorly a gentle contraction from behind forwards 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. The lateral trunk may be seen to swell with the wave, and the fluid then passes 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 *O. purpurea;* but this is a somewhat difficult task, on account of the transparency of the circulating 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.* Prof. KEFERSTEIN small oval discs in the reddish blood of his *Borlasia splendida,** and I have seen in *Ommatoplea purpurea* minute granular corpuscules, but both they and the fluid are colourless. Minute colourless globules also occur in the blood of *O. pulchra.*

Such, in the Ommatopleans, is a brief outline of the circulation, which, although resembling that of M. DE QUATREFAGES, in so far as each describes three main trunks, differs considerably in detail. The first point to be noticed in the descriptions of this author 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 its anterior border—in its passage outwards 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 au-dessous des couches sous-cutanées," as already described (Plate IV. fig. 1). He mentions the presence of distinct walls to these vessels, which, however, he learned from *Borlasia angliæ*, and in this I concur (Plate IV. figs. 1 and 6). The walls are highly contractile, and in the latter figure the vessels have been cut across just before they complete the cephalic arch; they are observed to be surrounded by a ring of finely granular texture. M. DE QUATREFAGES likewise

* This species has since been found in the Channel Islands. It is the *Cerebratulus spectabilis* of M. DE QUATREFAGES.

† *Op. cit.* pl. xviii. fig. 1. and pl. xix. fig. 1; also in his recent Hist. Nat. des Annelés, pl. iv. figs. 2 and 3.

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* 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.

Many of the older authors confounded the ganglia with hearts, such as EHRENBERG, HUSCHKE, DELLE CHIAJE, DUGÉS, 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† seems to have mistaken the edge of the proboscidian sheath under pressure for the blood-system, which he figures as two long straight trunks on each side of the digestive tract. The true blood-vessels he describes as the water-vascular system, but shows neither beginning nor ending, though numerous large branches are represented as issuing from them throughout their course. Prof. KEFERSTEIN‡ does not distinguish with sufficient clearness the different blood-systems of the Ommatopleans and the Borlasians; 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*, whose structure therefore differs from that usually exhibited by the British Ommatopleans. M. CLAPARÈDE,§ though his publication is more recent, is less correct than the latter author, for he figures the dorsal vessel as passing above the ganglionic commissure 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.

Nervous System.—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. As previously mentioned not a few authors, misled by their colour, pronounced them to be hearts. The aspect of the ganglia under pressure is indicated in Plate VI. figs. 1 and 3, *h*; and in large specimens they are pear-shaped under a lens. Each ganglion consists of two divisions—a superior, shaped somewhat like an almond, and an inferior, continuous with the great nerve-trunks. The first-mentioned portion is chiefly

* *Op. cit.* pl. xxi. fig. 3. *Polia sanguirubra.*

† *Op. cit.* p. 64, pl. vi. fig. 2.

‡ Zeitsch. für wiss. Zool. pp. 85–87, taf. v. & vi.

§ Beobach. über, &c., taf. v. fig. 10.

cellular, being composed of minutely granular nerve-cells, and is connected with its fellow of the opposite side by the *long* or *superior commissure* (Plate V. 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 is a simple ribbon of transverse fibres. As observed in the living animal, these fibres pass on to the superior lobe, where they diverge, some turning slightly forwards, but the majority passing obliquely backwards to the pale central part of the lobe. The only remark made by M. DE QUATREFAGES with regard to the physiology of this band is, that it removes the somewhat surprising state of matters of having a brain composed of two lateral masses, and only one ("sub-œsophageal") commissure. To me, however, this band seems of more importance, since, during the enormous distention which takes place in the extrusion of the proboscis, it is the superior commissure which is stretched to an extreme degree of tenuity. The proboscis, as mentioned, passes through a complete ring of nervous texture, and, during extrusion, forces this outwards in all directions, but chiefly superiorly, the inferior commissure, indeed, being little altered. Nearly half the circumference of the proboscis projects above the level of the ganglion (Plate IV. fig. 5), and the superior commissure must be correspondingly elongated; hence, if this is purely a nervous band, we have a very interesting example of the elasticity of such texture. It may possess elastic as well as nervous fibres, but such are not distinguishable. The *inferior commissure* consists of a thick mass of nerve-fibres, the majority of which sweep backwards to form the lateral nerve-trunks; thus it becomes an isthmus between these cords. A few of the anterior fibres are connected with the central region of the former division of the ganglion.

In long species, such as *O. gracilis* and *O. purpurea*, the ganglia are not correspondingly lengthened, but are rather rounded. In *Tetrastemma* the arrangement of these organs is very similar to that in *O. alba*, so that a special description need not at present be given, further than by referring to Plate VIII. fig. 7, which represents the ganglia in a small specimen of *T. varicolor*, where the inferior commissure is shorter and broader, and the lobes more elongated. This is also the case in *Prosorhochmus*. In the aberrant form, *Polia involuta*, VAN BENED., the ganglia are strictly Ommatoplean in shape, and the lateral nerves, which are not shown by the discoverer of the species, comparatively large. M. BENEDEN'S figure of the anterior branches of the ganglia is erroneous. The lateral nerves lie quite within the longitudinal muscular coat.

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 transverse diameter is across the plane of the body, each ganglion has its longest (transverse) diameter nearly perpendicular to the latter (Plate IV. fig 5, and Plate V. fig. 1). The nerve-cells do not appear to be confined to the superior portion, but occur in the inferior also

(Plate VI. fig. 1), where they are seen 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 nerve-cells from the softer interior do not pass through this, but escape by travelling along a portion of the great lateral trunk, and rushing out at its torn end, or pass along other branches, such as the superior and inferior commissures, and the anterior nerves, or through accidental punctures. The nerve-cells are of a yellowish tinge, and minutely granular (Plate VII. fig, 11), and rapidly alter their appearance after escape into the water. Many contain a larger reddish granule or granules, to which the colour of the organ is partly due; but I cannot say I saw all the numerous larger pigment-granules so located, although they might have been. In the fresh as well as in the prepared condition (Plate IV. fig. 5), 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, but the inferior more so; both are paler than the masses of the ganglia. The colour of the ganglion is not destroyed by sulphuric ether, but is rendered paler by acetic acid.

M. DE QUATREFAGES mentions that in a large *Borlasia* (*angliæ?*) he found the cephalic ganglia surrounded by a sheath forming a sort of dura mater, but he could see none in the smaller species. In the Ommatopleans, 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, form powerful bands between the ganglia and the inner muscular layer of the body-wall. M. DE QUATREFAGES mentions the occurrence of ventricles in the interior of these organs (ganglia), and figures them in *Polia berea;* such have never appeared in any British form, though, under pressure, collections of oil closely resemble the drawing given by this author I have also never been able to see so many branches proceeding from the ganglia (as he shows)* to the eyes, cephalic fossæ, "mouth," and other tissues from the anterior borders, in addition to the great trunks and other twigs posteriorly. The arrangement in the British Ommatopleans is represented in Plate VI. fig. 1, and consists of the following, viz., three very distinct branches on each side of the superior lobe anteriorly; two about equal in size; and a third much smaller, to the outer side. Traces of a fourth branch are also present. 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-branch with certainty. Dr M. SCHULTZE† gives a tolerably correct view of the ganglia and nerve-trunks in *Tetrastemma obscurum;* no branches, however, occur on the trunks in his figure. This author, in a later publication,‡ founded

* *Op. cit. e.g.* pl. xv. fig. 14; pl. xviii. fig. 1; pl. xix. fig. 1; and the whole of pl. xxiv.

† Beiträge zur Naturges. Turb., 1851.

‡ Zeitsch. für wiss. Zool. iv. 1852.

one of the chief distinctions of his *Enopla* and *Anopla* (Tremacephalidæ and Rhochmocephalidæ) on the structure of the ganglia. Prof. KEFERSTEIN figures only two branches, proceeding from the anterior part of each superior lobe to the eyes in his *Borlasia splendida*, but he represents a kind of mesh-work, 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. No equivalent arrangement to the two latter series has been seen in our species. M. CLAPARÈDE* figures the proboscis as passing beneath the great or inferior nervous commissure in *Prosorhochmus Claparedii*, and the central blood-vessel as placed above both.

The *great nerve-trunks* (*n*, in the various transverse sections), springing from the inferior lobes of the cephalic ganglia, pass backwards in this group 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 fibroid stroma of the parts. The branches given off by these trunks are generally pale and indistinct, but by the use of dilute acetic acid in *O. alba*, and in others without such aid, they can be satisfactorily observed. They are easily seen, for instance, in *O. pulchra*, the reddish hue 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 the same species. In this form also 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. The same constriction is seen in *O. purpurea*. In transverse section the nerves present a delicately granular appearance from the ends of the cut fibres. No one who has seized on such specimens as *O. gracilis* in semi-contraction (though unwrinkled), and drawn them out to treble the length and upwards, can doubt the peculiar elasticity that must pertain to the lateral nerves in these animals.†

The nerve-trunks were said by M. DE QUATREFAGES to lie "between the external longitudinal and internal transverse muscular fibres" of the body-wall; a description which may in some respects apply to the Borlasians, but is inapplicable to the present group. FREY and LEUCKART ‡ mention that the lateral trunks lie to the inside of the muscular coats; but while indicating the different arrange-

* Beobachtungen, &c. pl. v. figs. 10 and 12.

† The arrangement of the nervous system in the curious foreign Turbellarian, described under the names of *Bipalium*, STIMPSON and GRUBE, *Sphyrocephalus*, SCHMARDA, and *Dunlopea*, PERCEVAL WRIGHT, presents a considerable variation from the foregoing, just as the external form of the head and the digestive system do. SCHMARDA represents the cephalic ganglia as quite separated from each other, except by connecting cords, and the great nerve-trunks placed close together in the median line, with an intervening ganglion at regular distances.

‡ Beiträge zur Kenntniss Wirb. Thiere, p. 72.

ments of the "brain" in *Tetrastemma* and *Borlasia*, they do not explain the distinction in regard to the position of the nerve-trunks in these species. Prof. KEFERSTEIN likewise did not observe this essential distinction between the two groups, but considered *Cerebratulus* the type of the whole. He describes an otolite or two in the middle of the ganglion in a young *Œrstedia pallida*, but I fear such are only pigment-granules and cells, or collections of oil. E. GRAEFFE,* again, in some brief 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. If such were not pigment-cells or structures pertaining to the cephalic sacs, the Mediterranean form shows a most interesting advance on the British in this respect, as well as in having lenses to its eyes. Unfortunately, the author has not figured the structures.

The only British Ommatoplean, so far as I have seen, which shows a special structure in its eye-specks, is *O. pulchra*. In this species the pigment is grouped within a distinct capsule (Plate VII. fig. 8, from a dead, and therefore slightly injured specimen). The eyes in the living animal have a clear patch in the centre, from the projection of the lens-like capsule. In *O. 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, I have not satisfactorily made out a lenticular structure. In *Tetrastemma vermiculus*, which has frequently been sent me from St Andrews, the eyes of each side are connected by a longitudinal patch of dark pigment, so that in contraction the animal seems only to have two large crescentic eyes, of a very characteristic appearance.

Cephalic Sacs and Furrows.—Midway between the tip of the snout and the anterior border of the ganglion in *O. alba*, a furrow runs inwards and slightly forwards on the dorsum, ceasing, however, before the middle 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 as lateral notches. From the dimple mentioned in connection with the anterior furrows, a thick-walled ciliated duct on each side 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 VI. fig. 1, *m*); and from what is seen in translucent species, such as *Tetrastemma vermiculus*, it would appear to end in a *cul-de-sac*; the walls, moreover, under pressure are marked

* Beobach. über Rad. und Würmer in Nizza, Zürich, 1858.

with 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 circular cells. From the posterior end of the outer mass in such a view, a structure that appears to be 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 is seen to occupy a position to the outside of the cephalic blood-vessel, and somewhat above it (Plate IV. fig. 1, *m*), and to have a special space in the muscular stroma of the head. In large specimens the sacs contain many reddish pigment-granules, 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 *O. alba* 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 *O. melanocephala* they are less dilated than in *O. alba*. The coils of the ciliated duct in *O. gracilis* are most elaborate, and can be traced for a long distance backwards by the side of the nerve-trunk. In *O. purpurea** the external apertures are not so evident as in *O. alba* 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. The ciliated pit leading inwards is short. Like other parts of the animal, there is a considerable variation in *O. pulchra* from the typical form in the shape and position of these sacs as well as in regard to the furrows. The latter species has numerous short longitudinal or accessory furrows on the front of the ventral grooves, and in this respect is allied to the *Borlasia splendida* of Prof. KEFERSTEIN. 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. Each sac is filled with rounded granular cells, reddish pigment and other granules, has a ciliated duct anteriorly, which opens 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 and extends for a

* I have a strong suspicion that this is the same species as the *Borlasia camillea* of M. DE QUATREFAGES, which he places next *B. angliæ*, an association, if I am correct, founded on erroneous principles.

considerable distance backwards by the side of the lateral nerve-trunk. Besides these sacs there is in the snout of this worm a series of well-marked glandular organs in front of the ganglia, one of which lies on each side of the blood-vessel, and is connected with a large lobulated mass in the middle line. In structure these glands are allied to the foregoing, having in their interior rounded granular cells, pigment, and other granules. What in some views appeared to be a duct passed from the posterior end of the external lobule towards the cephalic sacs. Traces of similar glandular masses were seen in other species (*e.g. O. alba*) near the middle line of the snout, behind the cephalic sacs, and elsewhere. In *Tetrastemma* the sacs agree essentially in structure with those of *O. alba*, and in such translucent specimens as *T. varicolor* the ciliated posterior ducts are easily traced.

The slight furrows just described on the head in this group have been noticed by few investigators, and only Prof. 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* 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. The former species has a curious series of oblique furrows on the side just behind the snout, which are evidently homologous with those described in *O. pulchra*. M. CLAPARÈDE again figures on each side of the eyes in the young of *Prosorhochmus Claparèdii* 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 Ommatopleans; for he describes bridles or bands as passing outwards to the "fossettes céphaliques." In his *Polia bembix* he represents a large nerve passing from the anterior part of each lateral nerve-column, not far behind the ganglion, and which, after a course directed obliquely forwards, ends in a swollen granular manner 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 forwards and outwards, and ended in several branches at the fossa. In *Cerebratulus crassus* and *Nemertes peronea*, again, he figures the nerve as springing from the posterior part of the superior lobe. He does not seem surprised that the nerve-trunks to these fossæ should spring from sites so diverse as the front and back of the superior lobe and the lateral trunk. The disposition of an important nerve-branch in species of the same genus, or even in allied genera, is seldom so varied. The structure appears to have been misinterpreted in Ommatoplea, the sac having been 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.

* Zeitsch. für wiss. Zool. xii. 1863, pp. 81 and 82. † Beobach. über, &c. pl. v. fig. 12.

Van Beneden, though he noticed the sac in Borlasia, does not mention more than "fossettes céphaliques" in this group.

Organs of Reproduction.—The sexes are separate, and the generative products developed between the inner muscular layer of each lateral region of the body and the glandular digestive chamber, and enclosed in special cavities (Plate XI. fig. 2) formed by transparent membranous sacs (*e*), which are connected with the inner muscular layer of the body-wall. In the matured specimen the ova are observed to 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 leaving the body of the parent; and it is curious that they are not much less in bulk 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 lessened posteriorly from the encroachments of the ovaries. The sperm-sacs in the male generally have a pyriform or flask-shaped aspect, especially in the early condition, 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 finely granular, then cellulo-granular; and in the mature state it has a finely fibrous or streaked appearance from the spermatozoa. Sometimes both granules and spermatozoa occur in the same sac, and then the former are often observed to be somewhat regularly arranged (Plate VII. fig. 12). The spermatozoa in *O. alba* (Plate VIII. fig. 13) have a slight curve of the body, which gently widens from the tip and ends in a perceptibly larger rounded knob, from which the long tail proceeds. The mature males are easily distinguished from the females by their whitish or pinkish aspect, and their bodies are less bulged. The spermatozoa of *O. gracilis* (Plate IX. fig. 8) are most active wriggling structures, of a more slender shape than in *O. alba* or *Tetrastemma* (Plate VIII. fig. 14), appearing under a power of 1000 diameters as simple rods, slightly larger towards the end from which the elongated and very fine tail proceeds. The sperm-sacs are very numerous in *Polia involuta;* but the tenuity of the spermatozoa (Plate IX. fig. 9) renders their exact structure somewhat obscure. The body of the spermatozoon is elongated, gently curved, and slightly thickened at the end from which the tail proceeds. It is very common, moreover, to observe one or more minute clear globules attached to the body of the spermatozoon, so that the structure seems to have a tail at both ends, or a large flattened head. These appearances have misled even so experienced an observer as M. Van Beneden, who figures* these organs as possessed of a somewhat globular body, with a tail at each pole. But, independently of the strange exception which such a condition would make in Nemertean physiology, the frequent occurrence

* Recherches, &c. Mém. l'Acad. Belg. t. xxxii. pl. iii. fig. 11.

of more 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 foreign author. The spermatozoa in *Tetrastemma vermiculus* (Plate VIII. fig. 12), though minute, are amongst the most active of the group. These structures are slender at one end, and slightly dilate towards the opposite, which is furnished with a very long tail. Just in front of the posterior end there is in certain views a somewhat abrupt swelling of the body, as if from an adhering globule, but none were observed without the enlargement. The ova and spermatozoa in *O. alba* would seem to attain full development in February, March, and April; but the breeding-season of other Ommatopleans ranges from the latter month to November. When fully developed, the mode of depositing the ova and spermatozoa may be illustrated by the following account:—Two specimens, male and female, of *O. gracilis* were taken from a deep vessel, and subjected to examination in a large glass cell. In 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 were observed to issue from the sides of the body, rather past the middle, and gradually increased in number, both in front and behind. The body of 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 crawled about the vessel. The female specimen was now observed to protrude her snout from the mass of sand and mucus in which she was coiled, and crawling to the side of the vessel, deposited in a few minutes a group of ova, about three inches distant from the white edges of the sperm-cloud, and she retired again under the mass of sand and mucus. The change of water probably caused the male to eject his 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 ciliation for the time being was well marked. These openings, as in Borlasia, occur a little above the lateral nerve-trunk on each side, and even in specimens of *O. alba* not fully ripened, pressure forces the contents of the generative sacs in the same direction, although no aperture is visible.

Specimens of *O. alba*, which had been in confinement for seven months, deposited their ova about the middle of February; and that this is not later than in the free examples, the receipt of many mature specimens from St Andrews at the end of March proves. The actual number of ova was not counted; but in one instance the ova of a single specimen covered a circular space of more than half an inch in diameter. Occasionally, in a crowded vessel, they are found above the water-line, adhering to the glass in an irregular mass; but they are not connected together by other than accidental mucus, and easily fall asunder. There is, therefore, a marked difference in regard to the deposition of the ova between this group and Borlasia; 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 form *Polia involuta*, VAN BEN. The bulk of the worm considerably diminishes after spawning, and the body assumes a flattened form, especially marked in large examples. That impregnation of the ova (in *O. alba*) 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 into the surrounding water.

It is a mistake to describe, as Dr JOHNSTON, M. DE QUATREFAGES, and Drs FREY and LEUCKART have done, the ova as occurring in a free condition between the body-wall, and the *Darm* or digestive cavity. They are always contained in ovisacs. M. DE QUATREFAGES observes that he found at the reproductive season a milky liquid, containing corpuscles of conglomerated globules, in the generative cæca; and the succeeding descriptions and illustrations make it clear, as already stated, that he refers to the walls of the digestive cavity, and the special elements contained therein. Thus it is no wonder he had some difficulty in distinguishing the sexes in the early condition of the generative products, since the cells would be identical in every specimen. He indeed gives a tolerable figure of a cell from the wall of the digestive cavity, as one of the true stages in the growth of the spermatozoa;* and again refers (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 spermatozoa of *N. balmea* is incorrect, for the body is too short and thick. He considered that it was only after the granular corpuscles fell out of the cæca into the lateral cavities that they assumed their special characteristics as sperm-cells. He thus failed 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 situ*

* *Op. cit.* pl. xxi. fig. 4, and still more plainly in pl. xxii. fig. 2.

† *Op. cit.* pl. xix. fig. 6.

‡ Philos. Transact. 1858, p. 131.

as transparent objects. It is almost unnecessary to contradict the last statement. since small specimens of most of the species 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. MM. VAN BENEDEN and KEFERSTEIN give a correct account of the position of the ova and sperm-sacs in the body of 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 makes no mention as to how the ova are extruded, though he points 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 MM. BENEDEN and KEFERSTEIN. FREY and LEUCKART erroneously conjectured that the ripe ova were shed from the posterior end of the body, "as in Arenicola."

The unimpregnated ova in *O. alba* (Plate VIII. fig. 8) are pure white, and measure about $\frac{1}{72}$d 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 very active molecular motion in the surrounding water. At a particular point there is a very distinct process (micropyle?) (*d*), as if from the remains of a tube that led through the outer coat. In a few hours after deposition and impregnation the pale spot disappears, the yolk divides into two masses, and shortly afterwards into four. On the second day they are almost all in the mulberry-stage. In seven or eight days the contained embryo is observed to revolve within the capsule by aid of its cilia, and the majority are extruded from the 12th to the 14th day. The young animal is furnished with two eyes before bursting the egg (Plate VIII. fig. 11), and the coarse granular matter and globules of the digestive tract are apparent. In such a condition the wall of the ovum is readily ruptured, and in several instances the posterior end of the animal emerged first. No sooner did the young get over their labours of extrusion than they glided rapidly off, head first, in a manner that showed no training was necessary to enable them to progress. 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 paler space (Plate IX. fig. 1), that has on each side of it a dense mass of the granules of the digestive canal. To the outside of 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 IX. fig. 2, under somewhat less pressure. It will now be observed that there are four eyes, the anterior pair of which are largest, and correspond to the first pair. Occasionally a few have an additional pigment-speck or two on one side of the posterior pair. The anterior pair are nearer each other than the posterior, differing in this respect from those of the young Tetrastemma, whose eyes are equidistant in both pairs.* The two 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 their posterior termination. 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 and reservoir-region. No stylets are visible until much crushed, and then in one specimen two slender spikes, probably from the lateral sacs, were seen. The posterior region of the proboscis bends forwards, and becomes lost at *c*. Shortly after this the lateral stylet-pouches become very evident in some, 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 has no stylet (Plate VII. fig. 6). The specimen had really only granules in its sacs; but to save multiplication of figures one of them was deleted, and filled in with correct drawings of stylets from another example. There is no trace of a central stylet, but the central sac is filled with coarse granules, and they moved with the muscular setting around them, for at this time the latter showed distinct contractions. The muscular space (ϵ) behind the floor of the anterior chamber shows traces of an inner and special lining, which forms a transverse boundary in front. The basal sac is irregular in outline at present, and the shape less defined than in the adult, but, as development advances, the form of the "awl-handle" becomes more characteristic. The lateral stylet-sacs in a few days afterwards were generally furnished with stylets, but these organs were not so sharp and smoothly finished as in the older examples. When the central stylet appears, the granules of the basal sac have a more definite shape than represented in the figure. An outline of the two kinds of stylets is shown in fig. 6, Plate VIII., from the same specimen, and the disproportion between them is evident, thus confirming the previous statement, that each apparatus furnishes its own stylets. The central stylet (*a*) is generally more slender and acute, as well as longer than the lateral (*b*), which have a more globular head than in the adult. As the specimen increases in age, the disproportion between the two sets of stylets lessens—one or more of the lateral 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 con-

* It is curious that in the young of Planaria also four eyes should be a common arrangement: indeed, they are present in some species before the embryo leaves the egg.

tracted with force, so as to propel the granules, and even the glandular lining of the cavity itself, forwards to the front of the basal sac. The superficial granular glands of the stylet-region are also well developed.

Some weeks afterwards (and there was no difficulty in preserving them for this period, even without a change of water) four eyes were observed in the majority. The head of the worm is distinctly marked in crawling, and the cuticle richly ciliated, a few longer cilia occurring at the snout and tail. Ciliation is also very active in the cephalic pits, whose openings 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 are still 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 lateral stylet-sac (Plate IX. fig. 13) there are at least three well-developed stylets, whose heads still appear somewhat more globular than in the perfect animal, besides a headless fragment or two, and one or two clear globules. The normal position of these organs in the lateral 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, had made corresponding advancement, but no blood-vessels were 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 escaped by rupture at the posterior end, as in *Tetrastemma variegatum*, probably by passing through the anus. In the adult protrusion rarely occurs posteriorly, but almost invariably anteriorly.

The ova of *O. gracilis* (Plate VIII. fig. 9) are much smaller than those of *O. alba*, and when first deposited adhere together slightly, 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 of a dull yellow hue. Though there is no doubt the spermatozoa in this, as in other species, rapidly diffuse themselves throughout a large bulk 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 this, while a few seemed to have penetrated both capsules (Plate VIII. fig. 10). In six hours cleavage had proceeded much farther, so as to cause many to have the usual mulberry-aspect. In *O. pulchra* the contents of the ovaries are of 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 only a single ovum happened to be detained in an ovisac here and there, impregnated and developed.

Numerous specimens of *Polia involuta*, VAN BEN., were sent from St Andrews in April, loaded with ova, and their development could easily be followed out. The newly deposited eggs (Plate XIV. fig. 1), 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 Borlasia, so that the whole forms a tunnel of mucus, with the ova in its walls. The spiral condition of some of the masses was 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 XIV. fig. 2), 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 ciliary tuft or whip (Plate XIV. fig. 6). 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 of the ova the embryo had two reddish eyes, and some were extruded from the body of the parent in a free state, so that they sailed about actively through the water as ciliated pyriform bodies. The ciliation of the œsophageal region in those with the eyes was very distinct; indeed, after the other and apparently more delicate tissues of the animal had become disintegrated, this region was left in active ciliation—dissected out, as it were, by rapid decay. This 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 figure* represents the so-called *proglottis* as 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 parent-specimens having developing young in their interior are feeble, and almost in a decaying condition inside their sheaths, so that their inert bodies seem but the nidi for the growth of their progeny, each of which, pro-

* *Op. cit.* pl. iii. fig. 28.

vided with two boldly marked eyes, and other differentiated tissues, revolves rapidly within its capsule. This 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 longissimus* and others—the last efforts of the parental tissues being devoted to the reproduction of the species.

In *Tetrastemma variegatum* the ova are found in the body of the adult in June and August, and are deposited freely in the vessel. The same changes ensue in the egg as in the other forms, and the young are found in swarms beside the adults in the beginning of July and September. These young forms (Plate IX. fig. 15) are so mobile, that one scarce sees the body of the same shape for two consecutive seconds. The surface is coated with long cilia, by whose aid they are piloted through the water like infusorial animalcules; while, in addition, they are furnished with a single long tuft anteriorly, as described by M. VAN BENEDEN, in the young of his *Polia involuta*. The cutaneous textures are not distinguishable as separate layers, and the entire body has a cellular appearance, probably from the individual elements of the digestive cavity and the cuticular areolæ. No eyes are visible. About a week afterwards considerable progress had been made in size, but the cilia had become shorter in proportion to the bulk of the animal; and though the anterior and posterior ends showed a few conspicuous cilia, the long tuft was absent. There are now four eyes. In another week the stylet-region of the proboscis is nearly complete, the lateral often appearing before the central stylets. The usual mode by which the proboscis escapes under pressure is by rupture per anum. Thus there is a slight divergence in the development of this species, whose young move freely as eyeless organisms, each provided with a long ciliary tuft; while in *O. alba* two well-marked eyes appear in the young in ovo.

Dr SCHULTZE* first observed that his *Tetrastemma obscurum* was viviparous. He likewise stated that, in the development of the proboscis, the lateral stylets appear before the central, and as the animal grows older, he figures it with two loose stylets lying in the pit of the proboscis—an arrangement, as he supposes, for the supply of the central apparatus. 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 the region, as previously explained, demonstrates that there is no connection between the lateral and central stylets, save perhaps in the composition of the fluid with which both are bathed. Prof. KEFERSTEIN† again details the development of *Prosorhochmus Claparedii*—a species in which the young animals attain considerable advancement before extrusion, for they are found with four eyes, a well-developed

* *Op. cit.* p. 65, tab. v. figs. 7, 8, and 9.

† *Op. cit.* pp. 89 and 90, taf. vi. figs. 2 and 3.

proboscis, and other organs, before they leave the body of the parent, and on being set free have the same general form as the latter. The larger examples are often doubled within the body of 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 (as Prof. KEFERSTEIN and M. CLAPARÈDE* have done) as simply within the body-cavity of the worm, is wanting in structural accuracy. It is certainly a curious sight 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 certain species (*e.g.*, *Polia involuta*, VAN BENEDEN), in which, after deposition of the majority, a few ova are left in the body of the parent for subsequent evolution. It remains, however, to be proved 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 or stages, and the rest evolved in the body of the parent. By the examination of this species, I have been enabled to confirm many of the excellent observations of Prof. KEFERSTEIN and M. CLAPARÈDE; but, on the other hand, the determination of the actual position of the mouth in the same animal shows that it does not deviate from the typical Ommatopleans, and that the organ is situated not behind the ganglia, as asserted, but, like the others previously described, quite in front of the commissures. The mouth, moreover, is the most distinct of any I have examined.

It appears to me that such viviparous species do not form a group *sui generis*, but are connected by insensible gradations with the true oviparous forms. Doubtless, in the majority, some of the ova only are retained in the ovisacs, impregnated by the ubiquitous spermatozoa through the genital pores, developed in the sacs, and space afforded for the growth of the young animals by the stretching or rupturing of the membranous walls of the latter. It is a very interesting fact in connection with this subject, that Prof. KEFERSTEIN† has lately discovered a Hermaphrodite Nemertean (*Borlasia hermaphroditica*) at St Malo, in which the anterior sacs were found full of mature spermatozoa, and the posterior distended with developing ova. This can only be explained in one of two ways—either that the species is truly a hermaphrodite one, or that the spermatozoa are passed from the body of a male (in apposition) into certain sacs of the female through the genital pores, there to remain until the other contents of the female generative organs are evacuated.

BORLASIA.

Cuticular Tissues.—The skin in this group, for which *Borlasia olivacea* may be taken as the type, is allied in structure to that of Ommatoplea, though in the living animal its condition is frequently rendered obscure by the much

* Beobachtungen über Anat., &c., p. 23.

† Ann. Nat. Hist., 4th ser. vol. i. 1868, p. 229; and Archiv für Naturges. 1868.

greater development of pigment. The body is everywhere covered with cilia, which are most active in the lateral fissures, but longest on the papillæ of the snout. They may be seen in active motion under a lens in good light. Sometimes the motion of the cilia in the lateral fissures is suspended, and again set agoing, without evident cause. Dr WILLIAMS first asserts that the cilia are confined to the dorsal half of the body,* and then seems to contradict himself by saying farther on that the whole body is ciliated.† The latter, as above-mentioned, is the correct view.

In the living animal the cutis has a cellular aspect (Plate IX. fig. 4), the cells or areolæ measuring $\frac{1}{1000}$th of an inch or more, and most distinctly seen towards the tip of the tail in the adult. Sometimes a number of minute clear granules are observed overlying 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 IX. fig. 5), a state probably due to the peculiar arrangement of the fibres of the external muscular layer hereafter to be described. In some pale red specimens the coloration is observed to be 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 IX. fig. 6), and there were three clear granules in the larger of the two figured. The cuticular cells are finer in *Borlasia lactea,* MONT. MS., and the body is not clouded by the granular pigmentary matter. The superficial arrangement in *Meckelia annulata* (Plate IX. fig. 7) is similar, though the cells or areolæ are smaller, and the pigment-granules do not form themselves into streaks.

There are three tactile 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 X. 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 erected papilla in a radiating or fan-shaped manner. They are probably of great tactile service to the worm. Prof. KEFERSTEIN refers to a "transverse" tactile papilla on the snout of his *Cephalothrix longissima*, which differs from those usually seen in Borlasia, and resembles a slight pouting of the lining membrane of the canal for the proboscis.

Under pressure granular masses and globules of mucus resembling oil are extruded from the skin, as in Ommatoplea, and often congregate round the borders of fresh transverse sections. But, while in Ommatoplea there are only the ciliated and structureless epidermis, a single layer of cutis-cells and the basement-layer, before

* Report Brit. Assoc. 1851, p. 171. † *Op. cit.* p. 243.

the circular (external) muscular fibres are reached, in Borlasia the structure of the dermal layer is more complicated. Fine tranverse sections of *B. olivacea* demonstrate that underneath the ciliated epidermis (*c*, Plate XI. fig. 8), 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 this lies a pale structureless basement-layer (*d'*), the presence of which in *Cerebratulus* had misled Prof. KEFERSTEIN into the idea that it was 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 sections 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 the great *Lineus longissimus*. A thick compound layer is next encountered in *B. olivacea*, 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 cut 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 layer of the cutis (*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, the chief interstitial bands having a longitudinal direction. Towards the tip of the snout the texture becomes denser in transverse section (Plate X. fig. 4), and the pigmentary matter increases, especially just within the pale external layer of the cutis. A section still further back (Plate XII. fig. 2) exhibits a less dense arrangement, and the pigment is now for the most part grouped into a dorsal and ventral band. The general stroma consists of radiating and longitudinal fibres, the cut ends and granular matter being often situated in the axils of the radiating series. The pigment anteriorly attains its greatest density immediately beneath the pale external layer of the cutis, diminishing in quantity from this point inwards. 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 great tactile power.

In *Cerebratulus bilineatus*,* the arrangement of the two white median dorsal stripes is characteristic, for the pigment is strictly confined to the region corresponding to *d''* and *e* in Borlasia; and in transverse section they appear as two patches with an intervening pale space, bounded anteriorly by the basement-

* *Gordius tænia*, DALYELL, Pow. Creat. vol. ii.

layer of the pale exterior coat, and internally by the circular muscular fibres. In transverse section the cutis of *Meckelia annulata* contains rather small cells (Plate XIV. fig. 11), which retain much of their ordinary shape after mounting. The characteristic opaque white dorsal and lateral pigment-stripes pass throughout the entire thickness of this tissue, while the white touches on the sides that apparently correspond with the openings of some of the ovaries or sperm-sacs do not traverse the entire thickness, but lie towards its inner border.

The skin in many of the Borlasians, *e.g.*, *Lineus longissimus*, *Borlasia olivacea*, *B. octoculata*, *B. lactea*, *Micrura* (*Stylus*) *purpurea* and *M. fasciolata*, gives a marked acid reaction when tested with litmus-paper.

Muscular Coats.—The longitudinal muscular coat (*e*), which is incorporated with the former cutaneous layer at its commencement, is thick and powerful, and has a well-marked fasciculated aspect in transverse section. At the sides of the mouth, where this coat attains great development, and forms a strong lateral support, there is a very pretty radiated or somewhat arborescent arrangement of the interfascicular substance on transverse section (Plate XI. fig. 1, 2). Such a condition would permit 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 superficial 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, and it is between this and the former that the nerve-trunks are situated. It passes by the sides of the ganglia, and appears to merge into the wall of the passage for the proboscis in front of these organs. In *Cerebratulus bilineatus* this coat is decidedly thicker than usual, a condition which may be connected with the somewhat rounder form of the body generally in the species. Within the last-mentioned coat is a layer (*e″*) of longitudinal muscular fibres, similar in structure to the corresponding stratum in Ommatoplea. Like the former the fibres pass the ganglia to become connected with the muscular channel for the proboscis in the snout.

Certain peculiarities are observable in the dermal tissues of the large *Lineus longissimus* (Borlasia angliæ, QUATREF.), and since this species has been taken as the type of the Nemerteans by M. DE QUATREFAGES and others, it is necessary to enter somewhat minutely into the anatomy of the parts, as shown in the transverse and longitudinal sections (Plate XI. figs. 6 and 7). The external cuticular layer (*d*) is proportionally thinner than in the common species. The pigmentary layer (*d′*, *d″*) is divided by a definite black band (2), and is distinctly separated from the first or external longitudinal muscular layer by a curious translucent stratum (3, 3), which in transverse section (fig. 6) has a transversely barred arrangement with linear interruptions, which divide it into numerous and somewhat regular elongated spaces. In longitudinal section, again (fig. 7), 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 fig. 7 at once demonstrates. It belongs entirely to the cuticular elements, and with the interior pigmentary layer corresponds to the region *d''* in *B. olivacea*, which, in the larger species, attains much greater perfection, and becomes distinctly separated from the longitudinal muscular fibres. The only peculiarities in the muscular coats consist in the very evident transverse streaking of the external longitudinal layer (fig. 7, *e*), and in the presence of certain parasitic (?) cellular masses in it and the next outer layer. These masses lie in definite spaces, and consist of groups of rounded cells filled with granules. In the contracted state of the animal, as after preservation in spirit, the fibres of the circular coat in longitudinal sections are grouped in a wavy manner (*e'*, fig. 7), apparently from the extreme shortening of the parts.

In the arrangement of the muscular system of the body-wall the curious specimen from Balta is distinguished from all other British forms yet encountered. Externally (Plate X. fig. 2, *d'*), beneath the basement-layer of the cutis (which in the fragmentary specimen was almost absent), there is a layer of circular fibres (*e'*). Within the latter is a very powerful layer of longitudinal fibres (*e*), which (layer), however, is not continuous, as in Ommatoplea and Borlasia, but has at least one very distinct point of separation. Upon approaching the middle line of the dorsum in transverse section, this longitudinal coat becomes thinned off, so as to end on each side of the centre in a blunt point. In addition, there is a somewhat triangular portion (*ea*) 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 fissure of this muscular coat inferiorly. This arrangement therefore conforms to the Meckelian type, as seen in *M. annulata*, in which there are two muscular coats, with intermediate lateral nerve-trunks. The deviations from the ordinary aspect in the Zetlandic specimen may prove to be accidental.

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 *Borlasia lactea*, MONT., and the true *B. octoculata*, 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 longissimus* 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 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. A *Micrura*, again, from the deep water of St Andrews' Bay, swims freely on its edge like a fresh-water Nephelis, or its own ally *O. pulchra*, 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*, but he was not sure whether it was a natural condition, or caused by the confined vessel. *Meckelia annulata* forms in captivity a beautiful silky sheath by its cutaneous secretions, 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 cutaneous textures.

The posterior end of the body in *Micrura* (*Stylus*) requires special mention, since there is superadded a peculiar elongated and contractile style. This appendage 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 these coats is a central chamber, 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 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, whose warty formations seem to perform the functions of suckers, for the animal may be observed crawling about with a loose style, then the tip of the latter suddenly becomes fixed upon the clean and smooth glass, and the whole organ is elongated accordingly. The fixed portion at the tip is usually more dilated than the succeeding part of the style.

In *Cephalothrix*, ŒRST. (including Astemma), the dermal tissues, and indeed the entire body-wall, deviate from the ordinary structure in Ommatoplea, Borlasia, and Meckelia; and while the minute anatomy of this genus bears out the distinctions—based on external characters, and the form of the nerve-ganglia—given by Prof. KEFERSTEIN, its independent position can be more satisfactorily demonstrated. Externally (Plate X. fig. 3) there is the usual ciliated coating, whose action is most vigorous in the cephalic region. The cutaneous textures are exceedingly transparent, the pigment, if present, being only developed at the snout in front of the ganglia as a rose-pink or reddish shading within the superficial cuticular layer of the parts. The cutis (*d*), composed of the usual granular cells and gelatinous matter in areolæ, has along its inner margin a trace of a translucent homogeneous basement-layer. A very thin layer of circular fibres (e') comes next, the exact structure of which is best demonstrated in the 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 sections on account of their tenuity. Beneath this lies a very powerful longitudinal muscular coat (e''), the cut 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 coat 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 Borlasia, the circular muscular coat 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 crawling about 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 is able to push aside its own mobile body in any direction; while through any narrow loop of mucus the latter is drawn like a thread of semi-fluid, yet coherent substance. These animals also progress readily on the surface of the water. When tested with blue litmus-paper the skin of Cephalothrix gives a most vivid red stain.

DELLE CHIAJE'S* description of the structure of the body-wall, if applied to the Ommatopleans, is correct enough, viz., that there is an external layer of circular fibres and an internal longitudinal coat; hence the criticism of M. DE QUATREFAGES requires qualification. The *Polia siphunculus*, D. CH., however, seems to have been a Borlasian, judging from the large triangular slit which lies at a considerable distance behind the snout. H. RATHKE† gives *Borlasia striata* two coats,—an epidermis, and a corium,—combining under the latter both the pale and the pigmentary layers of the skin. He has omitted to notice 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

* Memorie sulla storia, &c., vol. ii. 1825.

† Neueste Schriften der Naturforschenden, &c. p. 95, 1842.

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 vacuoles 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 just noted agrees with his figures iv. and v., pl. 18. Two muscular coats only are described by this author—an external longitudinal and an internal circular—the internal longitudinal being omitted, or rather considered as an aponeurotic layer. He also commits a serious error in affirming that the structure of the dermal tissues in Ommatoplea corresponds with that in *Borlasia angliæ*. FREY and LEUCKART likewise describe only two muscular coats—an outer longitudinal and an internal circular. Prof. KEFERSTEIN,† while representing the cutaneous textures of Cerebratulus (a Borlasian) with greater accuracy, also falls into the mistake of applying what he found in this animal to all the Nemerteans. He describes the skin as composed of two coats,—a cuticula covered with cilia, and an inner thick, finely granular coat which contains the pigment,—a definition which is scarcely comprehensive enough for the nature of the parts in such as *Lineus longissimus.* 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. 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 Borlasians. Lastly, Dr ANTON SCHNEIDER, 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.

Cavity of the Proboscidian Sheath.—This forms a shut sac, as in Ommatoplea, from the bridge of the ganglionic commissure to the posterior end of the worm. The long proboscis glides smoothly in this chamber, whose walls are united with it and other tissues just in front of the commissure. The other contents are the clear proboscidian fluid and its discs. The latter are circular granular bodies, similar to, though smaller than, those of Ommatoplea, and when seen on the edge present a fusiform outline, having a swollen middle and two tapering ends. There are also a few small granules and granular cells. The muscular wall of

* *Op. cit.* pl. xxiii, fig. 1. † *Op. cit.* pp. 66–68.
‡ Müller's Archiv für Anat. 1864, p. 595.

this chamber and other points agree so closely, both structurally and functionally, with the same parts in Ommatoplea, that it is unnecessary to describe farther than refer to the aspect of the parts in the living animal (Plate X. 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 either in this group or in *Cephalothrix*. In *Meckelia annulata* the proboscidian sheath is not continued to the tip of the tail either, and it is an interesting fact that this absence coincides, as in the last-mentioned genus, with greatly enlarged lateral vessels. In Cephalothrix the chamber presents certain peculiarities, being subdivided by transverse bands of contractile tissue throughout its entire length, so that during the motions of the worm the anterior region is occasionally thrown into a series of moniliform spaces. These contractile septa (though imperfect in the middle), doubtless prove of much service during rupture—an occurrence so liable in this lengthened 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 bulging of the chamber during the motions of the worm. The transparent liquid of the cavity in this genus (Cephalothrix) contains flask-shaped bodies and minute clear corpuscles.

Prof. 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 his predecessors Frey and Leuckart,† who noticed the sheath of the proboscis and its contents.

Terminal Aperture in the Snout for the Proboscis.—A channel, ciliated for some distance, leads inwards from the terminal pore to the reflection of the proboscis just in front of the commissures. This channel, shortly after its commencement (Plate X. fig. 4, *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 within these is a series of longitudinal muscular fibres, which attain a more distinct development somewhat posterior to this point (*a*, Plate XII. fig. 2). A very beautiful group of circular and diverging fibres lies to the outside of the first-mentioned series (2, in the last-mentioned 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 stoma of the snout. The terminal

* *Op cit.* pp. 68 and 69. † Beiträge zur Kenntniss, &c. p. 70.

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, and each of the divisions supplied with cilia. In spirit-preparations of large examples of *Lineus longissimus* the proboscidian aperture is distinguished by a slight slit on the inferior surface immediately behind the tip of the snout.

Proboscis.—The proboscis (Plate X. fig. 1, *a*) commences as 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 forwards in the ordinary state of the parts, becomes attached to the wall of the proboscidian tunnel. Its cavity is continued 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 Ommatoplean organ in certain respects, such as the absence of the 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 a Borlasian from that of an Ommatoplean 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 swollen reservoir; but even where the organ is incomplete, a transverse section at once puts the question beyond doubt. This was illustrated in a well-preserved though shrunken fragmentary specimen brought by Mr GWYN JEFFREYS, the distinguished conchologist, from North Unst, Shetland. At first sight it looked like a Borlasian organ, on account of the absence of the stylet and posterior regions, and from its large size I thought it would demonstrate the structure in that family favourably, but a transverse section gave a true Ommatoplean anatomy, with the characteristic beaded and other layers; and an examination of the animal itself at once confirmed its relationship. In the living animal the organ is proportionally longer than in Ommatoplea, and when cast off becomes thrown into numerous screw-like coils. Thus do the two great groups of soft worms differ in essential characters; and we are taught how unsafe is that classification, *e.g.*, such as SCHMARDA's,* which proceeds on other than anatomical grounds.

A transverse section of the proboscis of a Borlasian (*Micrura*) from St Andrews is represented in Plate XII. fig. 1. Externally there is a coat (*a*) similar to that in Ommatoplea, 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 cut fibres in transverse

* Neue Turbel. Rotat. und Anneliden, vol. i. pt. 1, 1859.

section having the same histological characters as in Ommatoplea. 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 layer, and, slanting outwards, cross each other in such a manner 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 crossing 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 grouped 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 *B. olivacea*. At the other pole there is a variation in this arrangement, for it is found that an elongated portion (*g'*) is cut off without apparent crossing, the ends of the great longitudinal coat (*b*) being widely apart. 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 coat 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 belt 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 this species than in the common form (*B. olivacea*), is situated on the inner surface of the latter. There is also present in this species an incomplete belt of longitudinal fibres (*e*) within the basement-layer, and which is not evident in the species just mentioned. Attached to the inner surface of the basement-layer, or in the latter case partly to the incomplete longitudinal layer, 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 very pretty radiated 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 doubtless due to their passage outwards under compression. Prof. KEFERSTEIN* figures this in

* *Op. cit.* taf. v. fig. 16.

Borlasia splendida, but he does not refer thereto in his descriptions. In the fresh specimen it is found that the glandular papillæ are much smaller than in Ommatoplea, and widely different in shape (Plate VI. fig. 10, and Plate X. fig. 5), the former representing them in the extruded proboscis, the latter as viewed from without. Under ordinary circumstances they appear to have an ovoid shape, and to 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 an elongated and slightly barred aspect; and, after escape into the surrounding water, the contents are club-shaped or rounded (Plate XIII. fig. 9).

The usual crossing occurs at one of the poles of the circular section of the proboscis in *Lineus longissimus* (Plate XIV. fig. 8), but the separated piece at the opposite pole is somewhat larger than in *B. olivacea*. Like the latter, it also has no inner longitudinal fibres grouped exterior to the mucous layer. In the remarkable form* dredged in 50 fathoms off Balta by Mr JEFFREYS—and the structure of whose body-wall coincided with the Meckelian type rather than the Borlasian—the proboscis proceeded backwards from the tip of the snout in the usual manner, but instead of the posterior end diminishing insensibly into the long muscular ribbon, the organ divided into two nearly equal trunks (Plate XIV. fig. 12), each about as large as the entire portion, and terminated in a somewhat abrupt and swollen end, from which the long muscular ribbon proceeded. The wall of this peculiar proboscis, so far as I could make out from the single and rather unfavourable example, had the following structure:—Externally there was a circular layer which showed a few granules on the outer margin in transverse section; within this lay a powerful and apparently continuous longitudinal muscular coat, from whose inner surface the granular papillary mucous lining projected. The inner or free margin of the latter was comparatively smooth, a result probably due to the minuteness of the papillæ. Each of the forked portions had the same structure as the anterior region, and the thick longitudinal coat, after bending inwards at the posterior end of the swollen termination, became continuous with the muscular ribbon. The proboscis thus differed from the ordinary Meckelian form in the bifurcation, and in having no distinct circular coat within the longitudinal. It had no closer analogy with the Borlasian or other type.

In *Micrura* (*Stylus*), a true Borlasian, the organ is furnished with somewhat slender papillæ, which, under pressure, became lanceolate and pedicled, fusiform, or rounded with granular contents. When viewed laterally, the rounded or flattened papillæ that formerly seemed granular appear to be composed of a series of minute rods set closely together. In some of the elongated structures, however, under pressure, the striæ are longitudinal. When extruded from the organ into the water the elongated bodies in the papillæ cling together in some instances like fibrillæ, and their appearance in the prepared specimens is quite charac-

* *See* p. 375.

teristic, the inner or free surface of the coat being covered with a vast number of these elongated glandular structures. These are the baccillary bodies described by Dr MAX. MÜLLER,* but I have never observed in the British species any of the urticating organs mentioned by this author. The minute structure of the wall of the proboscis agrees with that in Borlasia, only the lozenge-shaped portion (*g*, Plate XII. fig. 1) in some specimens was longer than in *B. olivacea*, from the more gradual slanting of the fibres to the exterior.

In *Cephalothrix* the papillæ of the proboscis are acicular, and they are longest towards the anterior part of the organ (Plate XI. fig. 9). In transverse section the walls present a simpler structure than in Borlasia; and, though in the living animal an external circular and internal longitudinal muscular coat are apparent, the tissues become so confused after mounting, that I have not yet satisfactorily unravelled them.

Under the action of powerful irritants, such as alcohol, the animal detaches, in its 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 turned inside out. In *Cephalothrix*, again, it sometimes ruptures near the ganglia, and is drawn backwards by the ribbon of attachment and its own elasticity; and the animal seems to be 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 his *Cerebratulus Œrstedii* (which is only DALYELL's *Gordius tænia*), and threatening its prey, I fear it could not do much harm. The life-like vermicular motions of this muscular tube, both *in situ* and when cast off, have misled Mr BEATTIE† and others, so that they have described the organ as a young animal, and the possessor as viviparous, or else have 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 Ommatoplea; and the discarded organ, if not ejected, may be seen floating in the proboscidian cavity amidst much granular debris. Sir J. DALYELL§ states that the usual colour of the proboscis in *Lineus longissismus* 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 *Cerebratulus Œrstedii* (*G. tænia*,

* Observat. Anat. de Vermibus quibusdam Maritimis, Berolini, 1852.

† Ann. Nat. Hist., 1859.

‡ Dr BAIRD, in describing *Serpentaria Berryi*, n. sp., also alludes to the very common practice of ejecting the proboscis (not the alimentary canal) after immersion in spirit. It is a habit common to all the Nemerteans.—*Proceed. Zool. Soc.* Feb. 12, 1866.

§ Pow. Creat. vol. ii.

‖ *Op. cit.* p. 10.

DALYELL) 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 crossing of the fibres, it is misplaced on one side, and the entire figure is too indistinct for reference.

Digestive System.—The mouth in *Borlasia olivacea* 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 X. fig. 1, *w*. Certain broad pale lines radiate from the lips of the fissure (which lines in dark specimens are generally pale), an arrangement which led Dr G. JOHNSTON into the error of considering it a nerve-ganglion and branches. These radiating lines or folds are due to the same structural cause as those in the ciliated œsophageal region of Ommatoplea—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. In *Borlasia lactea*, MONT. MS., the mouth is situated very far back, leaving a long space between it and the ganglia. In *Cerebratulus*, again, the aperture is a longitudinal slit, somewhat less marked than in Borlasia. The mouth leads into a great ciliated œsophageal chamber (*j*), which commences anteriorly as a *cul-de-sac* behind the ganglia and cephalic sacs, and nearly closing in by its anterior wall the vascular lacunæ there, while it may be said to terminate posteriorly at a distinct incurving of its wall, by becoming continuous with the digestive cavity-proper. In the transverse section (Plate XI. 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 lips of the mouth (*w*) curve inwards, and gradually merge into the ciliated glandular texture of the cavity. A little further back the glandular substance becomes confined to the inner surface of the body-wall (though actually not closely applied thereto), leaving a large central space. In full perfection the chamber and glandular texture are seen in Plate XIII. fig. 6. The minute structure of the wall of this portion of the digestive cavity is similar to that of the ciliated œsophageal region in Ommatoplea, being composed of a thick layer of granular gland-cells and basement-substance, raised here and there into prominent rugæ, and richly ciliated on the

* *Op. cit.* p. 17. † *Op. cit.* taf. vii. fig. 5.

inner surface. The turning in of the borders of the region is an interesting circumstance, and demonstrates the distinction between it and the succeeding region, 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 ciliated character of the digestive cavity is apparent, probably because the greater firmness of the walls keeps the chamber somewhat distended. In certain lateral views of the animal, the distinction between the œsophageal and the succeeding region is very evident.

Though in the various drawings of transverse sections of Borlasia 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 by firm closure.

The second or great division of the alimentary tube extends from the point of inflection previously mentioned to the posterior end of the worm, as 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 favourably 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 *Borlasia lactea*, 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 masses of cells and debris may be seen revolving within the dilated anus before extrusion. In various examples a distinct anal papilla (Plate XII. fig. 7), furnished with a tuft of longer cilia, is seen projecting posteriorly.

In transverse section (Plate XII. fig. 3), 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. The parasites were first alluded to and figured by Dr G. JOHNSTON,* afterwards

* Magaz. Zool. and Botany, vol. i. p. 534, pl. xviii. fig. 1 **.

by Frey and Leuckart,* Kölliker,† Max Schultze,‡ Van Beneden,§ Keferstein,‖ and lately they and certain ova in this species by the author;¶ so that the subject need not be further alluded to here, save to observe that they are strictly confined to the region behind the streaked œsophageal division of the digestive tract, that they hang freely into the cavity, and that the ova mentioned in the last paper probably may not be connected with this particular species of parasite. The occurrence of these ova, however, in specimens so widely different in habitat as St Andrews and South Devon, shows that there is some constancy in their presence. The parasites occur in young specimens scarcely a quarter of an inch in length, and vary in size. When the animal has regained its condition in its native haunts after spawning, the granular cells of the digestive chamber become largely developed, so that in transverse section the body is rounder, and the entire central 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 becomes considerably diminished in size, and, in the living animal, more evidently ciliated when viewed from above. The minute structure of the wall of the cavity (Plate XII. fig. 10) has a considerable resemblance under pressure to that of the ciliated œsophageal region in Ommatoplea, 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 XIII. 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 *Cephalothrix* the lips of the oral aperture are frequently pouted outwards in the form of a short funnel, so that the animal resembles an elongated Distoma, and the ciliation of the entire canal is more apparent than in Borlasia. Some circular fibres around the mouth are evident in this genus, and probably exist also in Borlasia. The general arrangement in transverse section is seen in fig. 3, Plate X., and the same gregariniform parasites before mentioned, as well as an Opalina, likewise occur. In minute 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 in this respect are more exaggerated than in Borlasia. In one specimen sent from St Andrews in April, the digestive chamber was coloured of a fine pea-green instead of the usual pale pinkish hue—a state due to the uniform tinting of the cellular elements.

It may now be proper to refer to the presence of another parasitic animal which was found in several specimens of *Borlasia olivacea* from St Andrews in

* Beiträge zur Kenntniss, &c. † Zeitsch. f. wiss. Zool. bd. i. pp. 1 and 2, taf. i. fig 4.
‡ Beiträge zur Naturges. Turb., &c. § *Op. cit.* ‖ *Op. cit.* p. 70.
¶ Quart. Jour. Micros. Sc. &c., April 1867.

November. The animals infested by this parasite present a remarkable aspect, the posterior half of the dorsum appearing under the lens to be honey-combed and tracked by pale channels in every direction, as if a microscopic *Tomicus typographus* had been at work in their bodies. Under the microscope the vast net-work of pale channels have a minutely granular appearance, and numerous small, opaque, ovoid granular bodies likewise occurred. Upon rupturing the body of the worm, a large number of the peculiar structures (Plate XII. fig. 4) slid out of their investments, and sailed about in the surrounding water, generally, though not always, with the upper end in the figure first. They differed totally from the gregarinæ above-mentioned, many of which, however, were present in the same hosts. 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 lines, as in Opalina, though in a much more minute degree. Anteriorly, there is a conical portion (*a*), composed of three rather indistinctly-marked segments. Two well-marked annuli (*b*) succeed, the posterior part of the last being narrowed, so as to cause an evident constriction of the body-wall in many positions. Behind these are six nearly equal divisions (*c*), each of which often appears double, that is, has a broad anterior and a narrow posterior belt, as indicated in the figure. The posterior region (*d*) consisted of three indistinct segments. The body was minutely granular throughout, and an internal cavity was 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 was observed at either end. The opaque ovoid granular bodies (Plate XII. fig. 6), scattered profusely throughout the infected portions of the Borlasian, were evidently young stages in the development of this species, and they too were ciliated. Upon subjecting them to gentle pressure (Plate XII. fig. 5), transverse segmentation was apparent, the number of segments varying according to the degree of advancement. The parasites were very delicate structures; and in the free state soon broke up into cells and granules, after discarding their cilia as above-mentioned. Transverse section of the affected animals showed that they occurred both in the skin and in 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, and the digestive canal, constitute the common area of this creature's depredations; or if it was piercing the former on its way to the surface, or again passing towards the alimentary cavity to be voided per anum. The differently segmented condition of the full-grown specimens, and their internal structure, exhibit a higher type of organisation than the ordinary Opalina and Pachydermon, which again are more elevated than the Gregarinæ. The ease with which so soft and delicate an organism bores through and tunnels the tissues of its host is wonderful.*

The Borlasiæ readily feed upon fragments of mussel (as first noticed by Sir J. G. DALYELL). When a specimen has come in contact with a suitable portion, the mouth is enormously dilated, and the bolus, even though 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*, ejecting the bristles and indigestible portions afterwards per anum. A specimen measuring about three inches in length boldly seized the head of a large Nephthys, upwards of four inches long, and partially ingulfed its prey. The danger of putting rare specimens, such as *Micruræ*, together in a vessel is great, as the larger generally makes a meal of the smaller. While thus predatory and voracious, they are in turn tolerant of much injury; for instance, one specimen had its head and anterior portion seized and held in the stomach of a *Sagartia troglodytes* for ten minutes, yet the worm subsequently got free, and crawled about as if nothing had happened. After being put in spirit, they occasionally turn their bodies inside out, and expose the inner surface of the digestive cavity. In *Cephalothrix* the contents of the latter are easily observed, and often consist of fragments of its fellows of the same species.

EHRENBERG and DE QUATREFAGES 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*," says he, "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 that the ova escaped into this chamber. His views were rather erroneous, such as supposing that the first region of these worms was 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 separated 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 com-

* Since the foregoing was communicated to the Society, I find that Prof. KEFERSTEIN, in a recent paper, gives a drawing of a parasite very similar to the above, but he does not say more about it than simply mention, under the explanation of the plate, that it is an enigmatical body from the stomach of a *Leptoplana tremellaris*. Beiträge zur Anat. u Entwicklungeschichte Seeplanarien von St. Malo (Der K. Gesellsch. der Wissensch. vorgel. am 4. Januar 1868), p. 37, taf. ii. fig. 8. It is probable that the same parasite, as in the case of the Gregarinæ, may have a wide distribution.

† Annals Nat. Hist. xv. 1845.

posite animal, each perfect individual consisting of numerous and apparently still unformed or imperfectly formed individuals." Modern researches do not support any of these suppositions. Of the other British zoologists who have examined these animals, Dr WILLIAMS,* while admitting the digestive nature of this chamber, misinterpreted its true relations. He considered the organ as a closed sac filled with a milky fluid, and having many diverticula, into which the nutritive matter passed by exudation from the proboscis. He appears thus to have drawn up his description from an Ommatoplean, which possessed no large slit leading into the chamber. He denied the existence of the proper anus. While thus deviating from the true structure of the parts, he was 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 Borlasian (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." 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 *Cerebratulus tœnia* (his *C. Œrstedii*) he states that the digestive canal 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 corresponding to the intestine. I have not as yet noticed this in the British examples, which agree with the typical Borlasian form in the structure of the chamber, although the external aperture or mouth is somewhat smaller. Prof. KEFERSTEIN'S‡ description of the cavity as applied to Borlasia, though brief, is good, and his criticism of VAN BENEDEN'S view, in regard to the "liver" in the same group, fair.

Nervous System.—The cerebral ganglia or central organs form two large and conspicuous pale red masses situated a short distance behind the snout of the worm (Plate X. fig. 1). They differ in shape, as seen under slight pressure, from the same organs in Ommatoplea, each half being narrower and more elongated, so as to cause the entire arrangement to have the appearance of a horse-shoe 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

* Rept. Brit. Assoc. 1851.

† Powers of the Creator, vol. ii. p. 73.

‡ Zeitsch. f. wiss. Zool. xii. p. 70.

fibres of the cephalic region, besides the sheath-proper of the ganglia. The inferior commissure, often of a deep red hue, is well marked, and placed quite at the front. The anterior curves of the ganglia do not bulge so much forwards on each side as in Ommatoplea, 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 of the nervous matter agrees with that in Ommatoplea. On making a transverse section through the ganglionic mass just behind the commissure, 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 is somewhat ovoid, and the great commissure joins it with its fellow; while posteriorly each gives off the great nerve-trunk. 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 severing of the end of the upper lobe is not to be confounded with the free rounded sac which lies close behind, as demonstrated in 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 section 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.

In all the 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.

The great nerve-trunks (Plate X. fig. 1, *n*) leave the posterior end of the inferior lobe as in Ommatoplea, proceed along each side of the body, and terminate a little within the tip of the tail. Their calibre slightly diminishes as they course backwards; and their position is nearer the ventral than the dorsal surface. Branches no doubt 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 of the same reddish hue, and have, in addition, the proper sheath 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 Ommatoplean nerves, being situated outside the circular muscular coat, 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 Ommatoplea the nerves are within all the muscular layers. In *Meckelia annulata*, the nerve-trunks are not placed as in *Cerebratulus tænia*, which conforms to the Borlasian type, but lie between the external circular and internal longitudinal muscular coats. This arrangement is characteristic of the Meckelian type.

In *Cephalothrix*, the peculiarity of the ganglia (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 (Plate XIII. fig. 1). The lateral nerves are placed between an isolated longitudinal fasciculus and the great longitudinal muscular coat of the worm.

In regard to the innervation of the body by the lateral trunks, it is interesting to observe the very long time during which detached fragments of the body survive in several of the long Borlasians, such as *Cerebratulus tænia*, DALYELL, and the great *Lineus longissimus*. A specimen of the latter, for instance, 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 scarcely measured two inches at first, had now grown a body and tail that when crawling measured at least seven inches, and of course capable of much greater extension, 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 lay 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. A similar power of regeneration was observed in the anterior end of Borlasia, Cerebratulus, Micrura, and Cephalothrix, when only a fragment of the body was left behind the mouth; and in *Borlasia octoculata*, a very fragile species, reproduction of a complete head upon each of the fragments ensues, if not with rapidity, at least with certainty.* One of the most remarkable features, to continue the case of *L. longissimus* as a type, 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

* Proced. Linn. Soc., June 1868.

disseverance. 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 us some idea of the powers of regeneration and vitality possessed by these worms in their native haunts.

Mr H. GOODSIR criticises M. DE QUATREFAGES' description of the nervous system in Serpentaria and Nemertes, and denies its existence altogether, averring that microscopically the so-called nerve-trunks showed no nervous elements at all, but were 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 Borlasian ganglia) passing out from the cerebral ganglia to the narrow furrows 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 confined his examinations chiefly to Ommatoplean ganglia. 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 nerve-trunks. Nothing akin to this has ever come under my observation, and the minute anatomy of the region is adverse to the view. M. 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 *Ommatoplea purpurea*, and is apparently a Borlasian form, but I have not as yet seen any British representative. Prof. KEFERSTEIN is scarcely accurate in affirming that the ganglia in this group are larger than those of the Ommatopleans. In his figure of the parts viewed from the dorsum (Taf. vii. fig. 1), the cephalic sacs are not discriminated.

Lateral Fissures.—On each side of the head in Borlasia is situated an extensive fissure (Plate X. fig. 1, and Plate XII. fig. 2, *b*), which commences as a shallow groove at the anterior border of the snout, and terminates, as a reddish pit, somewhat abruptly, just beyond the entrance to the cephalic sac. A distinct narrowing of the anterior region occurs behind the fissures in *B. olivacea*, 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 XII. fig. 2). 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.

* Neueste Schriften, &c.

† Beiträge zur Kenntniss wirb. Thiere, p. 73, taf. i. fig. 15.

‡ *Op. cit.* p. 16.

§ Archiv für Naturges. 1855, p. 150.

The vapour of chloroform, if applied in sufficient quantity, causes them to cease entirely, but they again commence vibration on the partial recovery of the animal. Mr H. GOODSIR thought that the fissures 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, with which he disagrees, 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 vesicules ("ils se renflent là en vesicules"), which similate the ganglia, and which lead 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 terminated exteriorly by a sort of funnel, and this led 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 regarded these fissures as 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 to the exterior of the nerves, and extending to the tip of the snout; this, of course, is quite at variance with a true interpretation of the structures in Borlasia.

The cephalic fissures, as characteristic of the Borlasians, are absent in *Meckelia annulata*, their places being supplied by two pale curved grooves on the dorsum and two continuous transverse furrows on the ventral surface of the snout. The furrows are richly ciliated. In the remarkable form from Balta, the snout is surmounted by two curious frilled processes (Plate XIV. fig. 12, *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.

Cephalic Sacs.—At the posterior end of each lateral fissure, a funnel-shaped tube (*m'*, Plate X. 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 Ommatoplea. This globular sac 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 carefully made preparations and examinations of the adult animal, as well as observations on the young at various

* Mém. de l'Acad. Roy. des Sc. de Belgique.

† *Op. cit.* pl. i. fig. 5.

stages, remove all doubt on this subject, and show that these globular bodies 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 exterior border, but its general mass is not ciliated. The ciliated curve along the external border is well seen in young specimens, but the exact superficial extent of the ciliation is difficult to determine. In favourable examples the walls are observed to be furnished with 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 (Plate XI. fig. 1, *s*, *s*) on each side of the proboscidian tunnel, and are thus laved by the circulating fluid, which rushes forwards 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 previously, 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 *Meckelia annulata* 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 functions of these bodies would seem to be excretory. Their gradual advance in position and proportional diminution in size in the developing animal would seem to indicate that their function is more important in the young than in the adult. They are quite absent in Cephalothrix.

Prof. KEFERSTEIN does not enter into structural detail with regard to these organs in this group, but states they lie at the posterior end of the lateral fissures.

Eyes.—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 Ommatopleans, both as regards nervous elements and complexity of organisation. Some Borlasians have no eyes (a remark, however, which does not apply to *Lineus longissimus*), or have them only temporarily in their young state, like the developing oysters and Terebratulæ; while all the Ommatopleans possess them. It is a curious fact that in transverse sections of the snout (such as Plate X. fig. 4) considerable pigment-specks are seen towards the ventral surface.

* *Op. cit.* p. 12.—" En avant, ces vaisseaux aboutissent au-dessous des ganglions cérébraux, et, si nous ne nous trompons, ils se renflent là en vésicules qui semblent appartenir aux ganglions mêmes, et qui conduisent leur contenu á l'extérieur par un court canal excréteur aboutissant au fond de la fossette latérale."

Circulatory System.—The circulation in Borlasia diverges considerably from that in Ommatoplea, the vessels differing in definition, size, coiling, and contents. The main vessels indeed somewhat resemble long cavities, with contractile walls, within which floats a transparent fluid with corpuscles. I have referred to this system as the circulatory, but the current is driven by the contraction of the vessels now backwards, now forwards, 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 ventral, *r*, *r* in the various transverse sections, and in Plate XIII. fig. 2. These three vessels in Borlasia were first mentioned by RATHKE.* The dorsal is a large trunk situated immediately to the 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 trunks are distended in *B. olivacea* and *B. octoculata*, they occupy nearly the entire breadth of the worm under gentle pressure. These vessels are frequently swollen in various ways, sometimes being irregularly moniliform from dilatations, 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 XIII. fig. 2), some of which are forked. These transverse vessels have special contractile walls, and are not mere random channels, as may be seen in the longitudinal sections of the worms (Plate XI. fig. 7, 4). They are subject to the various changes of form noted in the larger trunks. The great longitudinal trunks are further connected by meeting at the tip of the tail (Plate XIII. fig. 2). The dorsal vessel generally contracts from behind forwards, and this causes the corpuscular fluid, not only to rush to the front, but also to flow 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 meshwork of vascular spaces (*u*, *u*, Plate X. fig. 1) around this organ, 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 forwards to unite at the ganglionic commissures, and the granules of the contained fluid may be seen rushing forwards in the one and backwards in the other. In addition to the smaller meshes surrounding the œsophageal region, two larger spaces are seen 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 seen under favourable conditions in the living animal (*e.g.*, as represented in Plate X. fig. 1), as well as in numerous transverse

* Neueste Schriften, &c. Danzig, 1842.

sections. I have not been able to see any blood-vessel in the tissues of the head in Borlasia. A distended pale portion may often be noticed 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 long pale species, such as *Lineus lactea*,* 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 channels forwards 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 XII. fig. 8; thus forming an intermediate link between *Borlasia olivacea* and the still more elongated post-ganglionic region in *Cephalothrix*.

In *Meckelia annulata* there are two great longitudinal vascular trunks (Plate XIV. fig. 11, *r*), which 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 Borlasia, and are continued forwards just within the border of the snout to meet in a vascular arch.

Whatever special function the œsophageal region may perform in regard to digestion, it is clear that 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.

In *Cephalothrix* I can only make out two great longitudinal vessels, whose positions are seen in the transverse section (Plate X. fig. 3, *r*), viz., 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 ordinary Borlasian type. 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 may be observed to contract regularly and swiftly from before backwards, sending a wave of fluid towards its posterior

* I am indebted to Mr PARFITT for living specimens of this species from Devonshire.

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 forwards by the side of the œsophageal portion of the alimentary canal without sub-division, pass along the sides of the proboscidian sheath in special cavities (*v*), as in *Lineus lactea*, in front of the former, and reach the ganglia, where they communicate. I have not actually seen a junction posteriorly, but analogy would lead us to suppose such to exist. There appeared to be little regularity or rhythm in the movement of the fluid in these vessels, both of which were occasionally seen contracting from before backwards at the same time. Generally, however, the contractions were alternate.

In the fragmentary specimen from Balta, transverse section of the anterior region (Plate X. fig. 2) showed 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*) lay outside the latter. The cavity was partly filled in the preparation with minute granular cells. This agrees with the arrangement in Meckelia.

Both Dr G. JOHNSTON 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 surround 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 seen there during the ejection of the proboscis. He shows several longitudinal vessels in Nemertes, which are not present in the British forms. I cannot agree with M. VAN BENEDEN's† views of the circulation in Borlasia, for he describes the lateral vessels as swelling out into vesicles when they approach the ganglia, and their contents 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 posteriorly communicates only with that of the opposite side, and concludes doubtfully thus:—"Le long des parois du tube digestif, on voit en outre plusieurs vaisseaux, mais dont les aboutissants sont difficiles à décourvir." Another deviation from accuracy is apparent from his remark (under *Cerebratulus œrstedii*) that "En arrière un gros vaisseau très-

* Ann. des Sc. Nat. 3me ser. tom viii. pl. ix. fig. 5.

† *Op. cit.* p. 12, &c.

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 Borlasia, and his figures and descriptions apply to Ommatoplea, 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 connected together by a pink band in the figure, as if 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* a true Borlasian arrangement is found.

Generation and Development.—The sexes are separate, as in Ommatoplea, 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, as observed in the transverse section through a specimen just before spawning (Plate XII. fig. 3).

In *Borlasia olivacea* the spermatozoa (Plate X. fig. 9) 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, they often adhere to a point by one end, and, spreading around this in a radiating manner, lash the surrounding water with their tails. The spermatozoa of *B. octoculata* (Plate XI. fig. 5) 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 longissimus* the outline of the body of the spermatozoon (Plate XI. fig. 4) is less regular than in Borlasia, and it seems slightly crenated or moniliform. A very long filament proceeds from the body at 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 ova are few and large in *B. olivacea*, smaller and more numerous in *B. octoculata*. Both ova and spermatozoa escape by pores on each side a little above the nerve-trunks, these apertures being often indicated by pale specks along the sides of the worm, and occasionally, as in *Meckelia annulata*, they are boldly marked by white spots. In this species also 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 lateral vessel on each side of the body. Thus far there is a certain

* *Op. cit.* pl. iii. fig. 4. † Zeitsch. f. w. Zool. xii taf. vii. figs. 3 and 4.

resemblance between Ommatoplea and Borlasia (to take, for example, *B. olivacea*), but the moment the ova pass from the animal, and the condition in which they do so, a decided divergence occurs. Instead of being deposited as free circular bodies, the products are here 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 deposit ova, 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, which when fresh is crowded with small ovoid granular corpuscles from the cutis, the ova are deposited in the 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 was curiously frilled and grooved on the ventral surface during deposition. When newly deposited the mucus is softer and less tenacious than it afterwards becomes, and the same may be said of the membranous flasks. The solidifying of the mucus is analogous to what takes place, under similar circumstances, in the egg-capsules of certain mollusca, *e.g.*, *Buccinum undatum* and others. 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 there instead of two, for sufficiently obvious reasons. The ova of *B. olivacea* 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 St Andrews rocks towards the end of April likewise deposited ova, so that some latitude in regard to date is necessary. The American examples deposited their ova 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 impurity of the water causes recently captured animals to lay their ova rapidly, as if from a kind of abortion.

The development of the ova in *Borlasia obscura*—a species apparently identical with our *B. olivacea*—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 only dwell on such points as have not been elucidated. Our British forms seem to

* Entwurf einer Syst., &c., p. 25.
† Boston Jour. Nat. Hist. vol. vi. No. 1, 1850.
‡ Zeitch. für wiss. Zool. bd. iv. 1853.
§ Archiv für Anat. 1858.

offer great facilities for such investigations, and I have had no difficulty in rearing the Borlasiæ at a long distance from the sea.

The ova on deposition in the flask-shaped capsules are uniformly granular and opaque; and when broken up, are seen 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 they are yet in the body of the female (Plate XIII. fig. 8). 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. As first pointed out by MAX SCHULTZE, DESOR committed an 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 up into a number of rounded masses, so that the ovum had a nodulated or mulberry-aspect. No clear spot was observed in the centre of these secondary masses. During the next four or five days the changes which ensue in the ova consist chiefly of sub-divisions of the vitellus, which daily become finer. There is now a pale spot in the ovum, and a few free granules and cells in the flask, as noticed by DESOR. The ova gradually become smoother in the outline from sub-division of the vitellus, and then only a few nodules appear here and there on the otherwise even circumferences. 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. They continue in this condition for about a month, and then a further change ensues in the contents of the flasks (Plate XIII. fig. 4); and the latter drawing will explain E. DESOR's discovery, as well as enable us 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 Borlasian within the ciliated coating; indeed, at an advanced stage, as in the middle of the flask represented in Plate XIII. fig. 4, the embryo seems as if 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 commits an 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, if anything, 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 XI. fig. 10)—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 debris 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. For a considerable time afterwards they crawl about in swarms amongst the gelatinous mucus, so that the latter has a curious aspect, 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 adult animals to crawl 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 fresh sea-water.

The foregoing development is thus much less complicated than the remarkable evolution of the Nemertean worm, called *Alardus caudatus*, Busch., from *Pylidium gyrans*, as described by J. Müller.* This form would seem to be allied to Sir J. Dalyell's *Stylus* (*Micrura*), since it is furnished with a process posteriorly; and the author states that most examples are eyeless. Leuckart and Pagenstecher† have also recorded another species of Pylidium, and the development of the Borlasian worm therein; and they remark that the mouth of the worm is in connection with that of the Pylidium—indeed the organ in the latter opens into it—a statement verified in the same volume of the "Archiv" by Krohn.

The young Borlasians, at the stage previously mentioned, are visible to the naked eye as small elongated worms, somewhat tapered at both ends, pale, or rather translucent in front, and opaque-whitish posteriorly (Plate XIII. fig. 5), and in structure now closely approach the adult. The whole surface of the body is richly ciliated, the cilia being especially active in the cephalic fissures, and still more so at the openings of the cephalic sacs. The ganglia are indicated by a paler 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

* Archiv für Anat. &c. 1854, p. 75, taf. 4.

† Archiv für Anat. 1858.

form of the latter, as well as the error into which those authors have fallen who have confounded the sacs in the adult 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, it curves forwards, and disappears. The proboscidian sheath (*o*) is observed to be 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 XII. fig. 7), with a ciliated line connecting it with the digestive cavity, is also apparent.

Shortly after reaching the degree of advancement shown in Plate XIII. fig. 5, the young Borlasians leave the gelatinous masses, and congregate at the water-line. Hundreds now perish from want of sufficient food, which in their native haunts is doubtless both abundant and suitable, while in the artificial circumstances and confined vessel it is denied them. Two and a half months afterwards the young animals are found still of the same whitish hue, and possessing only two eyes, rarely with 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, yet still possesses only two eyes. In this condition it has, doubtless, 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).

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 remarks that the ovisacs contain from one to a hundred ova in his *Nemertes communis;* but although deposited in a membranous sheath in September, no change had ensued

* *Op. cit.* p. 182, pl. xx. fig. 8.

in November. His figure of the spermatozoa of this species* is not correct, 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 while yet in the body of the parent, while others were only fecundated during or after deposition. The development of the curious form described by Mr ALEX. AGASSIZ,‡ which, commencing with an oral and anal circlet of cilia, gradually looses these and two short antennæ which subsequently appear, and assumes the form of Nareda (GIRARD) with two eyes, shows that the type of growth is different from that of any British species yet observed. The opening of the mouth (to all appearance) behind the ganglia points to some affinity with the Borlasians; but the absence of so important an organ as the proboscis, which very soon becomes conspicuous in all the young British forms, again leaves us in doubt as to its actual position. The young Nemertean described by Dr BUSCH,§ under the name *Alardus caudatus*, would seem to have some relation to *Stylus* (*Micrura*), since it possesses a very distinct tail. The apparent segmentation of the latter, however, is characteristic.

In *Cephalothrix* (*Astemma*) 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 paler aspect when their reproductive organs are fully developed, viz., towards the end of January and during the subsequent spring months. The spermatozoa (Plate XI. fig. 3) 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 about the two ends appear as clear dots. Though the animal is extremely elongated, the bodies or "heads" of the spermatozoa are comparatively short. The body of the female, with matured ova, presents a duskier or slightly fawn-coloured aspect, the ova, under slight pressure in the living animal, being arranged in dense transverse rows in each ovary. The total number of ova produced by a single female must be very great. In transverse sections they are seen to 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

* *Op. cit.* pl. i. fig. 13.

† *Op. cit.* p. 13.—"La vésicule germinative ayant disparu, le vitellus s'organise, et, avant la ponte, nous avons trouvé des embryons couverts de cils vibratiles."

‡ Ann. Nat. Hist., 3d Ser. vol. xix. 1867, pp. 208–214, pl. v. figs. 3–17.

§ Beobacht. über Anat. u. Entwickelung einiger Wirbellos. Seeth. Berlin, 1851, p. 111, taf. xi. fig. 8.

proboscis had been ejected. The ova are deposited from the beginning of February till June; sometimes adhering together in irregular masses by their edges or a little accidental mucus, at others scattered about the vessel in detached groups. In several instances, however, they were deposited in a translucent sheath of mucus. On deposition they have the aspect shown in Plate XIII. fig. 3, being of a granular structure throughout, with a clear spot and globule, and measuring about $\frac{1}{180}$th of an inch in diameter. The ova pass rapidly through the usual stages, and on the 11th of February the embryos were revolving rapidly in the egg by aid of their cilia, and in some cases hatched. The extruded animal (Plate XIV. fig. 3), under moderate pressure, has a globular form, but assumes various shapes when freed—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 revolves rapidly between the glasses. The body is opaque and granular, with the exception of the margin, which is somewhat paler, from the slight differentiation of the cutaneous textures. Externally, it is coated with long cilia, by aid of which it executes rapid motions, and a tuft anteriorly had the form of a long whip-like process, as during the progress of the animal it appeared like a single mobile thread. The body is sometimes pitted at the origin of the latter, while a slight papilla projects at the posterior end. When fixed between the glasses the cilia were soon pitched off, and the animal resolved itself into a number of cells and granules (Plate XII. fig. 11). In two days the animal is found somewhat elongated (Plate XIV. fig. 4), and the mouth (*a*) becomes more evident as 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 distinctly seen. Two days later considerable increase has occurred in the length of the body (Plate XIV. fig. 5), and from the more anterior position of the mouth, it is apparent that 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 of cilia 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 as 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. In 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 in length, 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 as 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 Infusoriæ, or danced to and fro like Ephemeræ in the air. Externally at this further stage of advancement they have still a coating of very long cilia (Plate XIV. fig. 7), which serve as natatory organs, the tuft (*c*) on each side being about thrice as long as the rest, while the long 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 molluscs and Balani are similarly furnished. The mouth (*a*), the œsophageal, and succeeding region of the digestive cavity are all richly ciliated. The whole animal is soft and delicate, and none of my specimens survived this stage.

We have thus in *Cephalothrix* a certain resemblance to the development of M. Van Beneden's *Polia involuta*, already described (see p. 369), 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 of organisation as shown by the differentiation of tissues and the appearance of pigment in the eye-specks. The shedding 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 casting 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 which occurs in the young Cephalothrix on each side of the snout, and which attains its full development after the long anterior tuft has ceased to be conspicuous, is connected homologically with the entrance to the cephalic sacs in the Ommatopleans and the fissures in the Borlasians, 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 form. 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 Ommatopleans, especially to *Tetrastemma variegatum*, *Polia involuta*, 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 Borlasians. Prof. Keferstein in his proposed classi-

* Ann. Nat. Hist. 2d ser. vol. xvi. p. 259, pl. vii.
† Annales des Sc. Nat. 3d ser. tom. x. 1848.

fication of the Order* rightly places the genus in a special Family, called *Gymnocephalidæ*, whose chief characteristics as described by him are:—Absence of cephalic fissures; brain like that of Polia, 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 Ommatopleans, 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.

ANNELIDA.

In the following part of the paper I purpose making a few remarks on the structure of some recent additions to the Annelidan fauna of Britain, as well as of a few species believed to be new to science. Many of them have been known to me for years, and, indeed, were figured and described in my MS. long before the appearance of M. DE QUATREFAGES's "Annelés" and Dr A. J. MALMGREN's "Catalogue of Northern Annelids;" but the publication of these and other recent works on the subject has occasionally anticipated me in nomenclature—a kind of loss, however, which I esteem rather lightly, since so much yet remains to be done in the minute structure of the entire class.

Amphinome vagans, LEACH (?)—Two genera have hitherto represented the British Amphinomea, viz., *Euphrosyne* and *Spinther*, and this species introduces with certainty a third. Two very minute specimens ($\frac{1}{4}$th of an inch in length), from St Magnus Bay, occurred in an extensive collection made last year (1867) by Mr GWYN JEFFREYS, while dredging in the Shetland seas. The segments numbered in the one twenty-three, and in the other twenty-seven. The head agrees with that of *Hipponöe*, AUD. and ED.,† with which genus I at first thought it most closely allied, but the feet are biramous. In these specimens also no caruncle can be observed, the head forming a smooth rounded eminence, from which a subulate antenna projects. No eyes are present. There are two antennæ in front of the median at the anterior border of the snout, and two others at a distance behind. The bristles (Plate XV. fig. 1) of the superior and inferior lobes of the feet agree in structure, and consist (1) of a somewhat stout kind (*b*, *c*), which has serrations on one side, and thus not observable in all positions; and (2) of various modifications of a peculiar bifid bristle, some of which (*a*), especially towards the posterior end of the body, show a swollen part below the bifurcation, with a short and simple limb, and a longer process serrated on one side, while others have the serrated limb extremely elongated and tapered to a fine point, and with little or no swelling at the bifurcation. The inferior cirrus is very small. A large specimen from the Channel Islands seems to belong to the same or a closely allied species, but there are sixty-seven

* Zeitsch. für wiss. Zool. xii. 1863.

† Hist. Nat. du litt., &c. tom. ii. p. 128, pl. ii B. fig. 10.

segments and four distinct eyes. The head in the latter is pale, somewhat horse-shoe-shaped, with two short conical tentacles in front, and two longer ones a little behind—opposite the swollen part of the snout. A curved line separates the anterior from the posterior region of the head, the former being flattened, the latter more elevated, and furnished with four reddish eyes, the anterior pair of which are about twice the size of the posterior. A little behind the anterior pair a filiform tentacle projects upwards in the middle line, and close behind this a wrinkled ridge (caruncle) extends to the anterior border of the third bristled segment. The sulci between the first three bristled segments are somewhat less marked, and the slope of the bristles more oblique, but the rest are very distinctly separated; indeed, the body has a somewhat moniliform aspect. The branchial tuft springs from a point behind, and rather below the dorsal fascicle, and consists of about four pale finger-like processes, which arise from a common basis; they commence on the second segment, and continue almost to the tip of the tail. In this example, the swelling below the tip of the bristles, corresponding to fig. 1, *a*, was not very evident, and the serrations of the extremely elongated distal portion widely separated; and, indeed, I was at one time disposed to regard the animal as specifically different. The bristles of these animals are extremely fragile, and the majority are broken during the efforts to decipher their structure. The crop commences at the posterior third of the fourth bristled segment, and extends to the posterior border of the sixth; it is truncated anteriorly and posteriorly, and swollen in the middle. The commencement is marked by two brownish specks. The published descriptions of the species of Amphinome make it somewhat difficult to determine them with accuracy, and I am by no means certain at present that SAVIGNY refers to this form under the above-mentioned name. I had provisionally termed the two minute eyeless specimens from the Shetlands *Hipponöe jeffreysii*,* but I think they may more correctly be grouped with the example last described. The *Eurythöe borealis* of SARS† is a very closely allied form.

Lœtmonice filicornis, KINBERG.‡—Three British species of the family Aphroditaceæ are recorded in the Catalogue of the British Museum, and one since the publication of the latter by Dr BAIRD; but I agree with Dr MALMGREN in considering *A. borealis*, JOHNSTON, only the young of *A. aculeata*, and the *Lœtmatonice kinbergi*, described by Dr BAIRD,§ as *L. filicornis* of KINBERG,‖ a species which abounds on our north-western and northern shores, just as *Hermione hystrix* does on our southern coasts. KINBERG does not show the recurved fang towards the extremity of the ventral bristles—an error probably due to the inaccuracy of his artist. The dorsal bristles are very large and powerful, and

* Ann. Nat. Hist. Oct. 1868.

† Christ. vid. Selsk. Forh. 1861, p. 56.

‡ Kongliga svenska Fregatten Eugen., &c., 1851–1853, p. 7, taf. iii. fig. 7.

§ Dr BAIRD is now of the same opinion.

‖ Proc. Linnean Soc. vol. viii. p. 180.

taper towards both ends, especially the terminal. The recurved fangs of the latter are not always readily seen until the bristle is turned round.

Lepidonotus pellucidus, EHLERS.*—Amongst the Lepidonoti dredged in Lochmaddy, North Uist, in 1865, this peculiar species occurred. The head has two rounded and prominent lobes in front, that do not form the acute angles seen in the common species. The eyes of each side are placed close together, while the pairs are widely separated, and situated far back. EHLERS's description and figures of the bristles need improvement. These structures throughout are pale and translucent, the superior fascicle of the foot having a series of slightly curved bristles (Plate XV. fig. 2, *a*), whose rows of secondary spines (about eight in number) are very wide apart inferiorly, while the tip of the bristle is notched, as if from a minute claw. Those of the ventral bundle are equally peculiar (*b*, same figure), having a short but well-marked claw at the tip, with a small spike adjoining. The terminal portion is somewhat flattened, and marked by oblique rows of secondary spikes, while it gradually widens inferiorly, and terminates in an abruptly dilated shoulder, furnished with a projecting series of secondary processes. The latter appeared to be similar to the spikes of the dorsal bristles, and the intervening angle was filled with debris. Dr EHLERS does not discriminate the bifid nature of the inferior bristles.†

Polynöe longisetis, GRUBE,‡ a species described as British by Mr E. RAY LANKESTER,§ under the name of *Harmothöe malmgreni*, though unfortunately, owing to the engraver, its bristles have not been figured with anything like recognisable accuracy, has been found after storms at St Andrews. It is distinguished at once from *L. cirratus* (*Harmothöe imbricata*) by the paler and more resplendent bristles which flank its sides, by the structure and greater pellucidity of its scales, and by the structure of its dorsal cirri. The dorsal bristles are almost identical, except in length, with those of *H. imbricata;* while the ventral, though formed on the same plan, characteristically exceed those of the latter in the length of the terminal spiked portion (Plate XV. fig. 3). The dorsal cirri (Plate XV. fig. 3, *a*) present scarcely any swelling below the tip, are pale throughout, and have only a few pale warts, so that the entire organ is much smoother than in the common species. *P. longisetis* exhibits a very close affinity with *Lœnilla glabra*, MALMGREN.‖

Halosydna gelatinosa, SARS,¶ a species first found on the shores of Norway by this celebrated naturalist, and afterwards by KINBERG** and LOVEN,†† is abundant

* Die Borstenwürmer, &c. p. 105, taf. iii. fig. 5, 7–13, and taf. iv. fig. 1–3.

† M. CLAPARÈDE probably refers to this species (in his recent work "Les Annélides Chétopodes du Golfe de Naples"), under the name of *Hermadion fragile*.

§ Archiv für Naturges. xxix. 1863. ‡ Linnean Trans. vol. xxv. p. 375, tab. 51, fig. 28.

‖ Nordiska Hafs-Annulater, 1865, p. 73, tab. 9, fig. 5.

¶ Beskrivelser og Jattagelser, &c. p. 62, pl. ix. fig. 25.

** Kongliga svenska Fregatten Eugenies, &c. p. 19, taf. v. fig. 26.

†† Cited by MALMGREN, *op. cit.* p. 82.

in the stomachs of cod captured off St Andrews Bay, and a few specimens also occur at low water under stones. In the scale of the living animal a series of radiating lines are observed to stretch outwards from the point of attachment. The dorsal tuft of bristles is not conspicuous, and consists of a series of delicate translucent bristles, with faint serrations at the tip. The bristles of the ventral bundle are characteristic (Plate XV. fig. 6, 6 *a*, 6 *b*), being pale, elongated, and flattened out at the tip in varying degrees. The claw at the extremity of the broad examples is short and strong, while the inferior division is slender. The oblique transverse lines from the rows of spines are also very distinctly marked.

Sthenelais dendrolepis, CLAP.* was dredged in 90 fathoms, off North Unst, Shetland, by Mr JEFFREYS.—It has rather the aspect of *S. boa*, JOHNSTON, than *Sigalion mathildæ*, AUD. and ED., but it can at once be observed that its bristles are more elongated than in either of these species. The form of the anterior scales also approaches that in *S. boa*, being somewhat quadrate, with one end rounded; but instead of having the simple papillæ which characterise the margin of the scales in the latter, the new species has peculiar pinnate processes (Plate XII. fig. 12); the whole having a tree-like figure, while the shape of the pinnæ and the contour of the process in general readily distinguish it again from the pinnate appendages on the scales of *S. mathildæ*. The process in the latter has a less robust form, its pinnæ are hyaline cylindrical processes; whereas in the present species they are lanceolate and granular lamellæ, with a narrowed papillary tip. The specific differences are likewise very apparent in the form of the feet and their appendages, the superior lobe being somewhat leaf-shaped or ovate, with a simple terminal process superiorly, and shorter than in *S. mathildæ;* the inferior lobe again has the spine-papilla much more prominent than in the last-mentioned species. While the bristles of *S. mathildæ* are proportionally more slender than in *S. boa*, here they exceed both in length, especially as regards the terminal process. There is a general resemblance in all the three species as regards the superior fascicle, but the inferior groups differ very characteristically. In the new species the superior bristles of the series with the jointed tips (which adjoin the short tapering-spiked forms) have the terminal portion of the shaft covered with whorls of somewhat sparse spikes (Plate XV. fig. 5), which (spikes) are much more numerous than in either of the others before mentioned; while the stouter series next these (Plate XV. fig. 4) have the same portion of the shaft closely and transversely rowed with minute spikes. The spikes on the terminal portion of the shaft of the inferior bristles are likewise more distinct, and the terminal clawed portion longer.

* Les Annélides Chétopodes du Golfe de Naples, p. 99, pl. iv. fig. 4, and pl. v. fig. 1. I had described this new species under the name of *S. buskii*, but the unavoidable delay in the publication of the present paper gives M. CLAPARÈDE's title the priority, if, as I am inclined to think, it refers to the same species.

Sthenelais limicola, EHLERS.*—Another species of Sthenelais, brought in numbers by Mr JEFFREYS from the Shetland seas, seems to be identical with Dr EHLERS's species from Quarnero, in the Adriatic. The anterior scales are furnished, towards the outer margin, with peculiar processes, which, so far as regards our examples, are uncharacteristically represented by the German naturalist. The processes are irregular, either simple, bifid, or divided into several pieces, and the margin of the scale is generally folded back under examination, so as to render them indistinct. In the first scale the processes are papillary and undivided. The dorsal lobe of the foot has four or five elongated papillary processes superiorly, and a peculiar broad and curved lobule projects upwards from the inferior lobe. The inferior bristles have their terminal clawed portions shorter than in *S. mathildæ*, and those corresponding to figs. 4 and 5, Plate XV. (*S. dendrolepis*), have only two or three spines at the terminal portion of the shaft. Dr EHLERS's figures of the bristles are not good, whether as applied to this or any other species of *Sthenelais*—no compound claw, for instance, appearing on the terminal process. The animal also possesses four eyes, instead of the two mentioned by the foregoing author, the anterior pair being hidden from ordinary observation in two sulci under the squamous processes at the base of the median tentacle. This may be the *Aphrodita arcta* of Sir J. DALYELL,† a species likewise brought from Shetland.

Notophyllum polynoides, ŒRSTED.—A specimen was procured from the deep-sea fishing, off St Andrews Bay. The feet are described by Dr MALMGREN,‡ as having the dorsal lamellæ of an elliptico-subrectangular or unequally reniform shape; and in this the new or regenerated plates were somewhat reniform, especially posteriorly, while the older inclined to an elliptico-subrectangular form. The new lobes are even at the edges, but the older are slightly frilled or waved—an appearance intensified by the coloured border of rich blackish-brown, which glistens in the play of light with a purplish-red iridescence. They are also characteristically marked with small groups of white grains. The structure of the bristles is represented in (Plate XV. fig. 9), and consists of a long smooth shaft, which terminates in the swollen end and jointed tip, seen laterally in 9 *a*, and in profile in 9 *b*. The terminal portion is finely serrated, and on each side of its base the shaft of the bristle sends off a series of short spikes, which are inclined towards the serrated edge of the terminal division.

Ophiodromus vittatus, SARS.§—Dredged rather abundantly on a bottom of tenacious grey clay and mud in Lochmaddy, in from four to eight fathoms, and rarely met with there under immersed stones at extreme low-water. Length, 2¼ inches; head small, distinct, furnished with five tentacles—two lateral on each side, and a median; the inferior or external lateral being furnished with a thick

* Die Borstenwürmer, &c. 1864, p. 120, taf. iv. fig. 4–7, and taf. v.

† Pow. Creat. vol. ii. p. 170, pl. xxiv. fig. 14.

‡ Nord. Hafs-Annulater, p. 93.

§ Forhandlinger i Videnskabs-Selskabet, 1861, pp, 87, 88.

basal joint, and a more slender distal portion. Eyes four, the anterior pair being larger as well as more distant from each other than the posterior pair. The colour need not be referred to further here, than by simply mentioning that the dorsum is of various shades of lustrous brown, banded at intervals with belts of pale iridescent blue; while the under surface is of a deep, dark madder-brown. The body dilates behind the head, attains its maximum about the anterior third, and then tapers towards the tail. It is proportionally thicker than in its allies (such as Castalia and Psamathe), and garnished at each side with long resplendent bristle-tufts, that glance with the varied hues of the rainbow, the effect being heightened by the two long hair-like cirri that stretch beyond them. The tail terminates in two long slender styles, which are shorter, however, than the cirri of the fourth foot from behind. Through the mouth is protruded a large proboscis, which is unfurnished with jaws or tentacular processes; and this assumes various forms after immersion of the living animal in spirit, or when killed by the salt water being impure in any degree,—sometimes being cylindrical, or presenting a constriction between the swollen base and distal rim.

The first four segments after the head bear modified limbs, each consisting of two long cirri. As soon as the foot attains its perfect condition, it is found to be distinctly biramous, thus at once demonstrating its distinction from all the Hesionea except SCHMARDA's *Cirrosyllis* (Pseudosyllis, QUATREF.) and ŒRSTED'S *Castalia*. The superior lobe, as observed in a fine spirit-preparation, consists of the long superior cirrus, which has a soft articulation at its base; an inferior cirriform branch, from the upper and basal part of which spring a series of elongated, slender, and tapering bristles, simple throughout. After attaining some thickness, the shaft (Plate XV. fig. 8) is observed to be striated longitudinally, and to have minute transverse touches, which, however, attain a larger development in the next series. The inferior branch of the foot also consists of two portions, a ventral cirrus, and a bristle-bearing process, from the posterior suface of which the somewhat stiff fan of jointed bristles emerges. In such forms the bristles of the anterior feet have shorter tips, while those of the posterior feet have more elongated terminal processes. Besides, in each foot in this species the terminal pieces vary in length, the shorter occurring superiorly and inferiorly, or at the edges of the fan. When highly magnified (Plate XV. fig. 7), the claw at the tip of the terminal piece is seen to be somewhat faintly marked, from the blocking of its curvature by a process beneath, and the serratures of the edge of the process very fine, indeed scarcely distinguishable near the end. The shaft of the bristle is obliquely striated towards the articulation, longitudinally throughout the rest of its extent, except as usual at the pale diminished base (where the striæ become indistinct), and marked by a close series of transverse specks or touches. The tip of this division of the foot ends in a cirriform prolongation. The jointed bristles of the inferior branch of the foot differ, as we might expect, from any other allied British form, such as *Psamathe fusca*, JOHST., and *Castalia punctata*, MÜLL., each of which possesses similarly jointed bristles, and has the serrated terminal portion peculiarly clawed. In *Psamathe* the larger size, the structure of the shaft, and the coarser serratures of the terminal portion (Plate XVI. fig. 2), distinguish it from *Castalia;* while the latter again (Plate XVI. fig. 1) has a much broader and proportionally longer terminal process than the present form. The distinction in this respect between the *Periboea* and *Podarke* of Dr EHLERS* and the latter is very apparent. Dr GRUBE'S genus *Oxydromus*,† with which the foregoing has certain affinities, has also an unarmed proboscis, but the feet are uniramous.

I may also remark that two very distinct species, or rather genera, have been included—on the one hand, by Dr JOHNSTON in Britain, and on the other, by several continental authors—under the name of *Psamathe punctata*. Some of the most recent foreign publications—such as the work of Dr EHLERS and that of Dr MALMGREN—do not sufficiently recognise the distinctions between the two. M. DE QUATREFAGES,‡ however, correctly separates them into genera, yet he places the synonym *Castalia punctata*, " ŒRST." under both. Dr MALMGREN,§ while correctly including the *Halimede venusta* of RATHKE ‖ under *Castalia punctata*, MÜLL., falls into the error of comprising Dr JOHNSTON'S species under the same head—a slip which would not have happened if this excellent observer had seen a specimen. Dr JOHNSTON'S species, for which, notwithstanding Dr EHLERS'S views, the original name of *Psamathe fusca*¶ may be retained, has a uniramous foot, with the terminal portion of the bristles characteristically marked shortly after its commencement by a series of larger serrations, which gradually rise to a maximum, and similarly diminish, before arriving at the middle of the process, into fine serrations that disappear before the clawed tip is reached (Plate XVI. fig. 2). All the bristles of the foot are not so boldly marked as this example, but in each there is a tendency to have a shorter terminal piece, with coarser serrations, than in those of its immediate allies, and the clawed portion at the tip is very distinctly seen, so that the bristle can be distinguished specifically at a glance. The shaft has also coarser transverse markings, and its distal end is somewhat less clavate than in *C. punctata*. The *Psamathe cirrata* of Prof. KEFERSTEIN,** also described by M. CLAPARÈDE,†† seems to me to be allied in the closest manner to *P. fusca*, if, indeed, it is not identical therewith. M. DE QUATREFAGES, however,‡‡ considers the annelids

* Die Borstenwürmer, &c. pp. 190 and 199, taf. viii.

† TROSCHEL'S Archiv für Naturges. 1855, p. 98.

‡ Annelés, vol. ii. 1865, pp. 100–102 and 106.

§ Annulata Polychæta Spetsbergiæ, &c. 1867, p. 31.

‖ Beiträge zur Fauna Norwegens, &c. (Nov. Act. Acad. C. L. C. Nat. Cur. &c.), p. 168, tab. vii. fig. 1–4.

¶ Loud. Mag. Nat. Hist. vol. ix. p, 15, 1836.

** Zeitsch. für wiss. Zool. bd. xii. p. 107, taf. ix. figs. 32–36.

†† Beobach. über Anat. &c. p. 55, taf. xiv. figs. 1–7.

‡‡ *Op. cit.* vol. ii. p. 41.

described by the two foregoing authors as distinct species (which I hardly think is the case), and classes them under the genus *Kefersteinia*. They also appear to me to be in all respects much more nearly allied to the Hesionea than the Syllidea. The *Castalia punctata*, MÜLL., again, has a biramous foot, whose compound bristles (Plate XVI. fig. 1) have on the whole a longer terminal portion, with finer serrations than in *P. fusca*. I have found it on various parts of the British coast.

Autolytus pictus, EHLERS.*—I agree with Dr R. GREEFF,† who, in his remarks on *Autolytus prolifer*, observes that the above species (the *Procerœa picta* of EHLERS) is, in truth, an Autolytus. It was first found in Britain under a stone in a rock-pool at Paible, North Uist, and again, in greater numbers, at St Andrews. Its length is about an inch. The dorsum is very prettily marked by a pale central band, with numerous and rather regular transverse branches, which, uniting with a pale lateral belt on each side, cut the sepia-brown pigment-masses into oblong spaces. The latter are minutely striated under the lens by fine pale lines, and the intervals dotted by almost microscopic pale grains. The first twelve or thirteen segments are darker in hue dorsally, and the intersecting lines paler; and in some the oblongs are decidedly paler in this region. Below the pale lateral belt, and just above the feet, a dark-brown band runs from end to end, intersected only here and there opposite the pale transverse belts by narrow pale lines. A dark patch of brown is placed behind the median tentacle, and from the latter two characteristic diverging pale lines proceed backwards. The under surface is of a pale whitish or flesh colour. These markings were well seen in specimens preserved for upwards of a year in spirit. The head is rather small, and appears at first sight to be supplied with two eyes only, which are situated laterally, and somewhat in front of the great median tentacle, but a careful examination shows two clear lens-like structures on each side, the larger towards the front of the pigment-mass, and the smaller behind. There is thus some difference between our description and that of Dr EHLERS, since he shows a posterior pair of eyes considerably behind the median tentacle, and quite separated from the compound group in front. This ocular region is richly ciliated, and so is the dark pigmentary portion on the sides immediately behind. The median tentacle had its place supplied in a few instances by two of equal length, but this is simply an abnormality. The segments (upwards of 100 in number) behind the three or four anterior rings are furnished with a rather short dorsal cirrus, a few simple spines, and a fascicle of bristles (Plate XV. fig. 11), which possess a short terminal piece, with a bidentate apex. I have not seen any with a tridentate terminal portion, as shown by Dr EHLERS. Towards the tail there is only a single conspicuous spine in each bundle of bristles, and, finally, a larger and smaller spine form the sole appendages to the feet. Here,

* Die Borstenwürmer, &c. p. 256, taf. xi.

† Archiv für Naturges. 1866, and Annals N. Hist. March, 1868.

also, as in many of the Syllidea, the terminal joint of the bristles undergoes various changes throughout the course of the body, being very short anteriorly, then lengthening, and again diminishing in size towards the tail. The latter is terminated by two short curved styles. Dr EHLERS found his specimens at Martinsica. M. DE QUATREFAGES groups this species under his Myrianida, as *M. picta.**

Pionosyllis malmgreni, n. s.—This species, dredged in the Minch, off Lochmaddy, and also procured at the latter under a littoral stone, seems to belong to Dr MALMGREN'S genus Pionosyllis,† but is distinct from the species described by him. The elongated terminal portion of the bristles (Plate XVI. fig. 10) is peculiar, from the somewhat rapid widening below the bidentate apex. Faint serrations are observed on the terminal or articulating end of the shaft. The present is distinguished from MALMGREN'S species, *P. compacta*, by the following particulars:—A shorter terminal portion to the bristles; the absence of the elongated simple bristles in the non-budding animal; the greater length of the palpi; and in the much more elongated condition of the tentacula and cirri, which, moreover, are distinctly moniliform. In a specimen having a two-eyed bud posteriorly, the latter had, besides the ordinary kind, a tuft of slender simple bristles, which did not reach beyond the others.

Under the title *Syllis armillaris*, Dr JOHNSTON seems to have included two very distinct species, the *S. armillaris*, MÜLL.—a form occurring very abundantly between tide-marks, and having a single claw to the tip of the terminal piece of the bristle, and another annelid equally common in the laminarian region and deep water, whose membranous tubes occur in hundreds on the blades of *Laminaria saccharina*, tossed on shore by storms. The latter is probably the species referred to by Mr GOSSE‡ under the name of *Syllis tubifex*, though various characteristics, such as the single tooth of the proboscis, and the exact structure of the bristles, are omitted. The palpi are of considerable length, joined at the base in front of the snout, and richly ciliated, besides having in front some motionless microscopic spinules. The processes of the head and the two next segments are most distinctly moniliform, as well as longest, and the succeeding cirri show the crenations in a diminishing degree. All have the microscopic spinules. The proboscis has a denticulated edge, though a third of the circumference is only minutely crenated, and it is furnished with a single pyramidal tooth. This region is usually thrown into prominent wrinkles. Several elongated papillæ are present in front of the anterior edge of the proboscis—some apparently directed forwards, others backwards. The proventriculus is studded with minutely granular glands. Segments about fifty-six in number. The bristles, which are similar to those represented in Plate XV. fig. 21, have a short,

* Annelés, vol. ii. p. 63.

† Annulata Polychæta, &c. p. 39.

‡ Ann. Nat. Hist. 2d ser. vol. xvi. p. 31.

bidentate apicial portion. The colours of this species are very beautiful, and it is brilliantly phosphorescent. It appears to fall under Dr MALMGREN'S genus *Eusyllis*, and to be most nearly allied to, though not identical with, his *E. monilicornis*. Another new British species, characterised by indistinctly articulated tentacles and cirri, four very large and unusually distinct eyes, very short bidentate apicial portions to the compound bristles, and the presence of long simple hairs, seems to be the *E. blomstrandi* of the same author. It was dredged in the Minch in 1865.

Syllis krohnii, EHLERS,* var.?—Found under a stone in a rock-pool at Paible, North Uist, in a tube of sand. In this animal every alternate dorsal cirrus is a third larger, more opaque, speckled with white dots, and, instead of passing transversely outwards like the others, curves upwards in a very graceful fashion, and is often coiled at the tip. The others are smaller, paler, also speckled with white dots, and longer than the diameter of the body. The ventral cirrus is very small. The bristles (Plate XVI. fig. 14) have a stout terminal portion, with an entire claw at the apex, and the edge is serrated. The curves of the terminal portion of the shaft are peculiar, and, in this respect, allied to MALMGREN'S *Syllis borealis*,† from which, however, the animal is readily distinguished by the characters of the dorsal cirri, and the more elongated condition of the cephalic lobes. Unless we are to mistrust the descriptions and figures of the dorsal cirri given by Dr EHLERS, the British form varies very considerably from the typical one. In no state were the alternate cirri club-shaped, and those of the third and fourth segments were small and nearly equal; whereas he shows them furnished with a clavated pair, and all much more distinctly annulated than in the British example.

Syllis cornuta, RATHKE.‡—A *Syllis*, dredged off the Hebrides by Mr JEFFREYS, presents certain characteristics which point to its identity with the above-mentioned species of H. RATHKE; and since it is doubtful (from the description at least) whether Dr JOHNSTON'S remarks§ apply to this animal or not, I shall briefly allude to its structure. The body, composed of fully 100 segments, is about an inch in length, and of a highly iridescent aspect, from the close plaiting of the fine muscular fibres. All the tentacles and cirri are moniliform. Each foot has a dorsal cirrus, divided usually into twelve segments, a bristle-papilla, and a short lingulate inferior lobe. The bristle-bundle is chiefly composed of the form *b* (Plate XVI. fig 15), which at first sight resemble simple bristles, as their articulating processes are usually hidden amongst the others. They have, however, a most minute bidentate tip. Some (*a*) again have an extremely elongated terminal process. Dr MALMGREN'S figure‖ represents the dorsal cirrus as furnished

* Die Borstenwürner, p. 234, taf. x. † Annulat. Polychæta Spetzbergiæ, &c. 1867.

‡ Beiträge zur Fauna Norwegens, p. 164, taf. vii. fig. 12.

§ Catalogue, &c. p. 192. ‖ Annulat. Polychæta, &c. p. 43, taf. vii. fig. 45 *c*.

with at least double the number of annulations described above, and the bristles are not characterised by the minute bidentate apex; moreover, only a linear or profile view of the elongated kind is exhibited, so that the characters required some further elucidation.

A species allied to the *Syllis macrocera*, GRUBE,* was found under a littoral stone at Lochmaddy. It had about the same number of segments as the foregoing, smooth cirri, and a very short apicial piece to the bristles. It was of a dull orange-yellow colour, with the head about as long as broad, the central tentacle longer than the lateral, and all extending beyond the lobes. The bristles (Plate XV. fig. 12) of the several fascicles do not vary to the same degree as in such as *S. armillaris*, MÜLL., and each has a blunt claw at the apex, with a rough edge, for the notches are irregular. The articular portion of the shaft ends bluntly.

Sphærosyllis hystrix, CLAPARÈDE.†—Two forms of this species were found at North Uist in 1865, the one in the littoral region at Lochmaddy, and the other in the Minch. The littoral form (apparently that described by M. CLAPARÈDE) was marked down the centre of its pale body by a moniliform yellow band (intestine). The body tapered anteriorly, and ended in a small snout formed by the united palpi. Eyes four, placed close together in pairs, the anterior only furnished with lenses. Segments thirty-two. The tuberculated dorsal cirri with their swollen bases were well marked. At the eleventh segment a series of flask-shaped bodies (buds)—two in each segment—commenced, and continued almost to the tail. These bodies were of a pale rose-pink hue, with a reddish spot in the centre, where the oil-globules were massed. They were nearly equal in size throughout, had the usual processes at the ends, and were all thrown off when the animal was placed in spirit. The tail terminated in two swollen cirri. The bristle-bearing papillæ were distinctly tuberculated, and furnished throughout with compound bristles (Plate XV. fig. 10, *b*), which had a delicate and rather elongated apicial portion with a simple claw at the tip, and a stout simple bristle (fig. 10, *a*) slightly bent towards the attenuated extremity. In addition, from the ninth segment backwards nearly to the tail, each foot was provided with a tuft of long filiform bristles, which stretched far beyond the others. It seemed an inactive animal, and lay rolling on the bottom of the vessel; and the numerous parasitic organisms on the bristles would likewise indicate a sluggish habit. In the other form (from the Minch) there were none of the last-mentioned filiform bristles, and the compound series, moreover, had a more elongated apicial piece (Plate XVI. fig. 9). The eyes also were in one specimen six, two larger ones posteriorly on each side, quite separated from each other, and two small round

* QUATREF. Annelés, vol. ii. p. 28.

† Beobach. &c. p. 45, taf. xiii. figs. 36, 37, and Glanures Zootomiques, &c. p. 86, pl. vi. fig. 1.

specks in front. In the second specimen the two anterior eyes were absent. Segments about thirty

Staurocephalus kefersteini, n. s.—On both the eastern and western shores of North Uist a species of Prof. GRUBE's genus *Staurocephalus** occurred under stones near low-water mark. Body of an orange hue, paler towards head and tail; length about an inch. Eyes two, black, situated near the posterior border of the head. The latter conical, the snout forming a somewhat blunt apex. Tentacles four, the anterior, arising from the infero-lateral region of the head, by much the largest, and having a short jointed process at the tip; the posterior pair, springing from the outer side of each eye, are annulated and much less. The large anterior pair can be coiled and twisted very prettily. The feet, instead of being furnished with a dorsal and ventral cirrus, as in most of the species, have only a small ovate dorsal and ventral process (Plate XVI. fig. 11, *f* and *g*) as their representatives, and they are scarcely more prominent than the bristle-papillæ; thus it approaches *S. erucæformis*, MGRN.; from which, however, it differs in the structure of the bristles and other respects. The superior fascicle of bristles consists of two series, a stout bifid kind (Plate XVI. fig. 11 *b*) with the long limb of the fork flattened and slightly clawed at the tip, the shorter truncate and rounded. The second series (fig. 11 *a*) are more slender, elongated, finely tapered, and definitely curved, with a limited number of slight serrations on the distal and convex side of the curve. The bristles of the inferior fascicle again are all compound and of one kind, the terminal portion being somewhat elongated, clawed at the tip, and without evident serrations on its edge. In regard to the length of the terminal piece, these bristles present a gradational arrangement, the longest terminal portions being superior, the shortest inferior. The extreme bristles of a single foot are shown in figs. 11 *c* and 11 *d;* and it will be observed that the swollen terminal portion of the shaft has a few serrations. The tail is terminated by two styles of moderate length, which, like the processes of the feet, are much shorter than in *S. ciliatus.* MALMGREN,† alludes to a drawing of a species of "Prionognathus," apparently different from the latter, which had been sent him by A. BOECK from Norway; but he gives no description.

Notocirrus scoticus, n. s.—At least three species of the Family *Lumbrinereidæ* have been hitherto described as frequenting the British shores, viz., *Lysidice ninetta*, AUD. and ED., *Lumbrinereis tricolor*, MONT., and *L. latreillii*, AUD. and ED. The two latter, however, have in all probability been sometimes confounded with the *L. fragilis* of MÜLLER, a species abounding on our northern and southern coasts. A fourth and very well-marked form, which I have designated by the above name, was dredged amongst tenacious grey clay in 6 to 9 fathoms in Lochmaddy, and subsequently in several parts of the Hebridean seas by Mr GWYN JEFFREYS. The

* *Prionognathus*, KEFERSTEIN, Zeitsch. für wiss. Zool. vol. xii. p. 99, taf. viii. figs. 13–19.

† Annulat. Polychæt. &c. 1867, p. 62.

head is of an acutely conical form, with two distinct eye-specks at its posterior border, close to the first transverse sulcus. Its body is much more slender than that of *L. fragilis,* and at once attracts notice by its characteristically marked segments, which, with the exception of a few anteriorly, assume quite a moniliform appearance. In the structure of its feet it differs from all the foregoing species. Each foot is furnished with a small branchial lobe (Plate XVI. fig. 17 *a*) in which a single vascular loop is observed; and thus it would appear to fall under the genus *Notocirrus,* SCHMARDA,* though the possession of the eyes is exceptional. The tip of a stout spine or two (*b*) projects beyond the foot amongst the bristles. The latter (*c*) have simple shafts with a broad spear-tip, which tapers to a fine point, and is faintly serrated along part of the edge.

Hyalinœcia sicula, QUATREF. (?)—This is a small representative of the *Onuphididœ,* dredged in 90 fathoms off North Unst, Shetland, by Mr GWYN JEFFREYS, F.R.S. It is characterised in spirit by two parallel bands of brown which course along the lustrous dorsum from a transverse belt of the same colour immediately behind the head, and by a brown spot between each foot from the fifth backwards. There are three elongated tentacula (a median and two lateral), and two shorter in front, as in *H. tubicola,* MÜLL. The small black eyes are situated at the outer side of the base of the long lateral. All the tentacles have a crenated base. The antennæ are similar to those of *H. tubicola,* or perhaps slightly longer. In the structure of the bristles of the anterior feet, however, a very diagnostic feature occurs; for instead of the large unjointed winged hooks, which are found in the latter and in *Nothria conchilega,* SARS, there are peculiar jointed structures (Plate XVI. fig. 3); and the bristles (fig. 3 *c*) are slender, and furnished with a very narrow wing, whereas in both of the other species they are shaped like a Valentin's knife. Posteriorly the jointed hooks are supplanted by two simple ones (fig. 3 *b*), which are stouter and slightly curved. Some of these occasionally present no wing at the tip. The bristles in this region are also shorter, and some are characteristically curved at the point. None of the peculiar brush-shaped bristles common in the two species above-mentioned occurred in this animal. No tube accompanied it; but I have since found that this species inhabits a tube composed of gravel and shell-fragments, and thus differs very considerably in its habitation from *H. tubicola,* while the length and form of the tube also distinguish it at once from that of *Nothria conchilega.* The foregoing animal has certain close affinities with the *Onuphis sicula* of M. DE QUATREFAGES,† but differs from the description of that author in so far as the bases of the tentacles do not occupy the whole surface of the head, which in the Sicilian species is very small. The body is rounded in the latter, flattened in the British; and the bristles of the former are said by M. DE QUATREFAGES to present a great resemblance to those of

* Neue wirb. Thiere, &c. tom. i. ii. p. 114.

† Annelés, vol. i. p. 352.

O. tubicola, a statement at variance with the characteristics of the present species. The persistent brown stripes and spots also had not been seen by M. DE QUATREFAGES.

Eumenia jeffreysii, n. s.—This curious form, which I have been unable to identify with any known species, occurred amongst the annelids dredged by Mr JEFFREYS off the Hebrides in 1866, and again amongst those from Shetland in 1867. The length is about 1½ inch, and the outline of the body somewhat fusiform, the greatest diameter being at the anterior third. The head is small, furnished with two short thick tentacles, which give it a bilobed aspect, and is generally retracted within the papillose anterior region in the preparations. The mouth opens on the ventral surface just behind the snout. The structure of the skin and the arrangement of the rugose annulations resemble the same parts in Travisia, Scalibregma, Eumenia, and their allies; but the animal essentially differs from each of the foregoing in having no trace of branchial filament or appendage. The tail has several elongated processes around the anus. The ventral surface is in some cases marked by an elevated median line. There are about thirty segments, each of which has three rings. A double row of isolated papillæ runs along each side from the snout to the tail, the summit of each process giving exit to a fascicle of bristles composed of two kinds, viz., numerous long, simple, hair-like bristles, tapering to a very fine point, and a shorter forked series (Plate XVI. fig. 5). The only other case in which I have up to this time met with such bristles, is in a remarkable fragment of the posterior end of a small yellow annelid from Lochmaddy, which may have some relation to MONTAGU'S *Nereis pinnigera*. The foot had an elongated unjointed dorsal, and a shorter ventral lobe, and possessed two fascicles of bristles, each of which consists of long simple bristles, and a few of the forked kind mentioned above.

There is much in the foregoing description that agrees with *Eumenia crassa*, ŒRST., but the absence of the branchial filaments is diagnostic. Dr BAIRD had received this species from the same source, and kindly sent it, with other rare and doubtful specimens, for my examination. He likewise recognised the absence of the branchiæ, and his preparation was labelled "*E. ebranchiata* (?)." The *Vermiculus crassus* of DALYELL* had no bristles, and cannot easily be recognised from the description or figure.

Chlorœmidœ.—Two examples of this family have been recorded as British, viz., *Trophonia plumosa* and *Siphonostoma uncinata*, both of which abound in Scotland. Another species of Trophonia, dredged by Mr JEFFREYS in the Hebridean and Zetlandic seas, is recognised specifically by the absence of hooks in the inferior rows, and the substitution of the jointed bristles. It agrees with the *T. glauca* of MALMGREN;† but this author does not specially point out the essen-

* *Op. cit.* p. 88, pl. x. fig. 11.

† Annulat. Polychæt. &c. p. 82.

tial change in regard to the inferior appendages of the feet. As contrasted with the common species, the joints or transverse markings of the bristles are much more boldly indicated in this form, especially in those from the inferior fascicles (Plate XV. fig. 13 *b*). The latter bristles (inferior) are shorter than the superior, and both, as usual, have larger joints than the anterior series. A second representative of the family (*Siphonostoma buskii*, n. s.), from the Minch, off Lochmaddy, North Uist, is remarkable for its deep-red colour throughout, a hue so unusual in the group. The two long tentacles or palpi are pale, but the branchial filaments are deep red. The surface of the body is furnished with minute papillæ, which have the enlarged terminal portion furnished with a knob at the tip. The hooks (Plate XVI. fig. 4) differ very much from those of *S. uncinata*, in so far as the shaft is much longer and less robust, and the terminal claw more elongated, and abruptly curved. When the latter breaks off, it separates obliquely at *a*, a little above the articulation, leaving the short spike through which the dotted line passes. A bristle is shown in fig. 4 *a*, and a fragment more highly magnified in Plate XV. fig. 13 *a*.

Maldanidæ.—Two species of this family (*Clymene*, QUATREF.) are mentioned as British by the authors of the Catalogue, both of which are of doubtful identity, and apparently referable to the common *Clymene lumbricalis*, FABR.* (*Nicomache lumbricalis*, MGRN.), though this is by no means certain. Mr E. R. LANKESTER, in his list of the Annelids collected at Guernsey† in 1865, notices a third species—viz., the *Clymene amphistoma* of SAVIGNY. The explorations of the coast line in the Hebrides, and dredging in the surrounding seas by Mr JEFFREYS and myself, as well as the cruise to the Shetland Islands last summer by the former experienced investigator of our seas, have considerably augmented the number of the British representatives. One of the most remarkable species is the *Rhodine Loveni*, MALMGREN,‡ which combines an entire anal funnel, with a pointed snout, and has its characteristic hooks (Plate XV. fig. 16) in a double instead of a single row, thus materially differing from the others pertaining to the family. The outlines of the hooks of the British species differ insome details from those represented by Dr MALMGREN—a discrepancy in all probably due to the inaccuracy of his artist. The *Axiothea catenata*, MGRN.,§ was dredged recently by Mr JEFFREYS, off St Magnus Bay, Shetland, in 80 to 100 fathoms. Besides having an infundibuliform anal funnel, with alternate longer and shorter filaments, the base of the cup is marked exteriorly on the ventral surface by a continuation of the median line. There are about forty processes on the margin of the funnel, a smaller one, and sometimes two, occurring between the longer filiform divisions. The base of the funnel is surrounded

* Faun. Grœnland. p. 374.

† Annals Nat. Hist. May, 1866.

‡ Nordiska Hafs-Annulater, &c. 1865, p. 189; and Annulat. Polychæta, &c. p. 99, tab. x. fig. 61

§ Annulat. Polychæt. p. 99, tab. x. fig. 59.

by a distinct cup or fold exteriorly. The anal nipple, moreover, is roughened by small papillæ. The bristles are slightly winged below the tip, and under a power of 700 diameters show minute serrations at the margins of the wings. Instead of hooks, the first bristle-bearing segment has three very stout spines gently curved at the tip, and the second and third four of the same character. They have a distinct shoulder, and the chitinous substance is strongly striated longitudinally. Only a small portion of the tip is usually seen beyond the skin. The hooks in the segments which immediately follow have the processes above the great tooth somewhat fewer (four to five), but the rest have six; and in those of the last row, in front of the anal funnel, the denticles are even more numerous towards the crown. The great tooth comes off somewhat stiffly at the base, and its upper curve is not sinuous. Dr MALMGREN does not notice the peculiar spines anteriorly, but simply mentions that the hooks are fewer in those segments, and omits several characteristics described above. There are no hooks on the soft lobulated processes which succeed the last bristle-bearing segment, with its conspicuous transverse pad. The frontal lobes form two very prominent laminæ.

Another species, the *Praxilla prætermissa*, MALMGREN,* is not uncommon on our western and northern coasts, inhabiting sandy mud at a depth varying from four to eight fathoms. In a large specimen the teeth of the anal funnel are 27 in number. The hooks are characteristic, having about six teeth above the large fang, and a well-marked interval between the latter and the origin of the spinous tufts. The first three segments have simple and strong spines with the apex slightly curved. There are also a few shallow crenations on the margins of the cephalic lobes. A somewhat rarer species is *Praxilla gracilis*, SARS,† two specimens of which appeared in the rich collection brought by Mr JEFFREYS from the Shetlands. The hooks of the first three bristled segments differ from the others, and are spines with the apices more curved than in Axiothea, so as to resemble a hook furnished with the large fang only. A third species of *Praxilla* from the same region (North Unst, St Magnus Bay, and the Outer Haaf), while agreeing in several particulars with *P. prætermissa*, has its funnel-teeth much more filiform and distinct—in one instance 14 in number. The hooks (Plate XVI. fig. 13) have the large fang short and powerful, with the spinous filaments arising close underneath, and a numerous array (seven to eight) of diminishing teeth superiorly, the whole forming a very elevated crown, indeed it is the most elevated of the series in this respect. The curves of the hook, especially the posterior, are characteristic. The bristles are also peculiar, for instead of the usual winged margin, the whole shaft is flattened out towards the translucent tip, very minutely serrated at the edges, and tapered to a delicate point. The shaft below the flattened portion is, as usual, finely striated longitudinally.

* Nordiska Hafs-Annulater, p. 191.

† Fauna litt. Norveg. ii. p. 15, tab. 2, figs. 18–22.

This may be MALMGREN'S *P. artica*,* but as he only says as to its characteristics that it is similar to *P. prætermissa*, with the exception of having six teeth on the crown of the hook, we are left quite in doubt as to his species.

The anterior portion of a specimen of *Clymene ebiensis*, AUD. and ED.,† also came from Shetland. It is recognised by the pointed snout, the somewhat swollen anterior segments, and the absence of the usual frontal flattening. The shape of the hooks (Plate XVI. fig. 12) is peculiar, the chief fang being short, and the crown somewhat flattened. There are five or six teeth above the former. The curves of the organ and its coarse striæ are also characteristic. I could not find in this specimen either spines or hooks in the first three segments. The figure of the hooks given in the "Règne Animal" is quite unfit for identification. The species is also allied to Prof. GRUBE'S *Clymene leiopygos*,‡ from Cherso, though his drawing of the hooks is widely different.

The *Ammochares ottonis*, GRUBE,§ has been found abundantly, at St Andrews, in the stomachs of cod, at Lochmaddy under stones near low water, and dredged by Mr JEFFREYS in Shetland and the Minch. The bristles are rendered hirsute by microscopic spines, as shown by Dr MALMGREN;‖ but the hooks of the rasp-like belts have a much more characteristic shape than represented by this author's artist, since they are figured without any shoulder, and with the curve at the back of the beak too prominent. Their exact condition is shown in Plate XV. fig. 14. There are three tufts of longer and more delicate bristles in the British specimens on the first region, instead of two, as shown by Drs GRUBE and MALMGREN; but one may have been overlooked from its minuteness. I am inclined to believe, judging from MALMGREN'S paper, that the *A. assimilis* of SARS is the same species as the above. Dr CARRINGTON of Eccles describes this species¶ under the name of *Ops digitata*.

Of the family of the *Ampharetea*, MALMGREN, several representatives new to Britain have occurred. One species, the *Amphicteis gunneri*, SARS, though unnoticed in the recent Catalogue of the British Museum, had been found by Mr GOSSE at Ilfracombe, and described by him under the name of *Cróssostoma midas*.** Dr MALMGREN†† mentions another form, the *A. sundevalli*, which is characterised by having nineteen hook-bearing processes posteriorly, whereas the former has but fifteen; the bristles also have the winged portion striate, and the upper part of each hook widest, while in *A. gunneri* the corresponding region of the bristle is smooth, and the hook widest in the middle. Our common Hebridean and Zetlandic Amphicteis has certain of the characters ascribed to each of these species,

* Annulat. Poly. Spetz. &c. p. 100.
† Cuv. Reg. An. iii. pl. xxii. fig. 4.
‡ Archiv für Naturges. 1860, p. 91, taf. iv. fig. 3.
§ Archiv für Naturges. 1846, p. 163, taf. v. fig. 2 *a*, *b*, *c*.
‖ Annulat. Polychæta, &c. tab. xi. fig. 65 D.
¶ Proc. Lit. & Phil. Soc. Manchester, 1865.
** Ann. Nat. Hist. vol. xvi. 1855, p. 310, pl. viii. figs. 7–12.
†† Nordiska Hafs-Annul. taf. xix. fig. 46 D.

for the bristles agree with those of *A. sundevalli* in having the winged portion striate; while the hooks are widest in the middle (Plate XIV. fig. 14), and there are but fifteen hook-bearing processes posteriorly. A boreal form, not uncommon in the Scotch seas, is *Ampharete artica*, MALMGREN, the hooks in this species being furnished with a large number of teeth (Plate XIV. fig. 13). The former examples possess frontal bristles, but two species in Mr JEFFREYS' Hebridean and Zetlandic collections have none. The first is the *Sabellides sexcirrata*, SARS,* wherein the hooks have for the most part five teeth, though some of the larger have six (Plate XVI. fig. 16 *a* and 16 *b*). Occasionally one occurs in the centre of the row with only four large teeth. The other species was in a very imperfect state, but seems to be an *Amage*, MGRN., having about fourteen bristle-bundles on each side, somewhat club-shaped smooth tentacles, and the ventral bars very distinctly marked. The hooks (Plate XIII. fig. 10 and 10 *a*) have four or five teeth, and differ so much from *A. auricula*, MGRN., that in all probability the animal is distinct.

The descriptions of the British *Terebellæ* given in the Catalogue of the British Museum stand very much in need of revision, it being difficult, indeed, in some cases to understand what species is meant. Thus *T. conchilega* could not be identified from the characteristics there noted. The *T. nebulosa* of Dr JOHNSTON is not that of MONTAGU, but a very different form, with 24 pairs of bristle-bundles (he says 23), and well-marked hooks, with the chief fang very long and several smaller processes above it. It may be remarked in passing, that in such a profile view all the small hooks on the crown are not seen, and hence the armature is greater than at first sight appears. This species attains a very large size on our western shores. Dr MALMGREN† proposes for it the name of *Amphitrite Johnstoni*, but Sir J. DALYELL had long previously called it *T. figulus*.‡ The true *T. nebulosa* is described in the Catalogue under *T. tuberculata*, DALYELL, and MONTAGU's name, at any rate, must stand instead of MALMGREN's recent title, *T. debilis*. The hook of this species has two very distinct fangs and a greatly elongated base.

In addition to the twelve species mentioned in the Catalogue no less than eight new British forms require notice. In *Terebella* (Nicolæa) *zostericola*, ŒRST., a very abundant species, the hooks (Plate XV. fig. 15) are furnished with a single fang above the large one, and in some cases with a trace of a second. *Pista cristata*, MÜLLER, a species with a single pair of whorled branchiæ, was first got at Lochmaddy, and since at various parts of the coast; its hooks are characterised by the singular form represented in Plate XV. fig. 20, with three or four prongs above the chief fang, and a powerful process for the ligament at the posterior end

* Fauna litt. Norveg. ii. p. 23.

† Nord. Hafs-Ann. p. 377.

‡ Pow. Creat. vol. ii. p. 191, pl. xxvii. figs. 1 and 2.

of the enlarged base. This animal is quite different from the *T. maculata* of Sir J. DALYELL, which may be a species having a speckled aspect in spirit, a single pair of branchiæ, and hooks of the form shown in Plate XIV. fig. 15. The *Grymœa bairdi*, MGRN., a form nearly allied to *Thelepus circinnatus*, FABR. (*Venusia punctata*, JOHNST.), was dredged in 90 fathoms off St Magnus Bay, Shetland, by Mr JEFFREYS. It is at once distinguished from the latter by the much greater prominence of the bristle-papillæ, and the greater length and lustre of the bristles themselves throughout the entire body. The hooks resemble those of the common species (*T. circinnatus*) very much, but the process for the ligament is not so near the tip of the upper curve as in the latter, and the organs are proportionally smaller. The tube is composed of fine grains of muddy sand, instead of the coarser and stronger structure of *T. circinnatus*.

Amongst the Polycirridea from the same region is a very interesting form, called by Dr MALMGREN *Lysilla loveni*, and distinguished by the largely dilated cephalic lobe, furnished with numerous clavated grooved tentacles along its margin, and a cluster of tangled filiform processes inferiorly at each side. The whole of the anterior dorsal region is densely tuberculated with papillæ, which, from the intervening lines, assume a transverse arrangement. On the ventral surface, which is thrown in contraction into two prominent longitudinal folds with a central depression, the swollen portions are covered with somewhat larger tubercles than the dorsum, but the depressed central region forms a nearly smooth line of demarcation. There are six pairs of foot-papillæ in front, each having a short tuft of simple slender bristles, whose tips in the preparation are entirely within the summit. From the same source as the latter there is also the anterior fragment of another curious and new example of the same sub-family, *Polycirrus tribullata*, n. s., which has neither bristles nor hooks. The head and tip have the usual tentacles. The body has no ventral plates, but only a raised central line. There are three pairs of well-marked circular truncated papillæ (on the sixth, seventh, and eighth segments), each consisting of a raised ring externally, with an elevation in the centre. Two minute papillæ were visible in front of the first flattened process, but only a trace of an elevation occurred on the lateral region of the succeeding segments, which were two-ringed. The cuticle has a minutely granular aspect. The remarkable lateral processes may act as suckers. Two species, which come under Dr MALMGREN'S recently constituted genus *Ereutho*, are not uncommon in Britain. They are distinguished from other Polycirridea by having thirteen pairs of bristle-bundles. The first, which seems closely allied to *E. smitti*, MGRN., has hooks (Plate XV. fig. 17), which possess only two fangs, and a very much produced and characteristically striated basal process. The hooks of the other species (Plate XV. figs. 18 and 19) are much smaller than the foregoing, and so exactly resemble the figure by MALMGREN from a specimen of *P. aurantiacus*, GRUBE—forwarded by Prof. GRUBE himself—that one may be allowed to have some doubt as to the correctness of previous descriptions with regard to the number of the bristle-bundles. The last of the group is *Trichobranchus glacialis*, a species which Dr MALMGREN has only described from a spirit-preparation.* This form was dredged in six to eight fathoms in Lochmaddy, in 1865, as well as got under a stone amongst sandy mud at low water. Length about ¾ths of an inch when moderately extended. Of a general blood-red hue, or dark-red anteriorly, paler posteriorly. In shape the body is irregularly fusiform, ending anteriorly in rich red lips, with a translucent projecting collar at each side, leaving the dorsal and ventral edges free. From the dorsum, slightly posterior to the fissure thus left, spring a tangled series of tentacles, which are easily differentiated into three groups, even in the spirit-preparation. The most conspicuous, long, thick cylindrical processes, varying from four to six in number, arise distinctly behind the others, from the dorsal edge posterior to the cephalic frill, and are distinguished by a bright-red central vessel, as well as by the frequency with which they are thrown into spiral curves. They are capable of great extension, and seem more especially homologous with the branchiæ of the Terebellæ. In front of the latter series is a dense mass of short, pale-pink, thread-like tentacles, while a number of larger, clavated, red-streaked ones, arising from the border of the lip, are in the centre of these. The latter become grooved in contraction. In fine specimens, the varying habit of these three groups of tentacles is very marked. Four annulations occurred on the ventral, and three on the dorsal aspect (the first not being visible after immersion in spirit), before the bristles appeared. These are ranged on fifteen prominent papillæ, and during life are frequently directed forwards. The arrangement of the bristles in the fascicles is peculiar, for they are grouped in pairs—a large and small one alternately—to the number of six (twelve bristles). The latter (Plate XVI. fig. 8) are proportionally strong, and taper from a little above the base to a slightly bent apex. For about a third of the distal portion, there is a very narrow wing or border at each side, which has minute striæ directed forwards and outwards. A row of hooks runs in a transverse manner on the ventral surface from each bristle-papilla, the anterior rows being closer to the papilla than the posterior. These hooks (Plate XVI. figs. 6 and 7) have an elongated and slightly-curved form like those of Terebellides, the head possessing a strong beak, behind which are a series of small processes or fangs. There is a distinct narrowing or neck below the head, and the hook gradually tapers from the succeeding shoulder backwards. This form of hook is confined to the somewhat prominent pads of the bristle-bearing segments. A series of elevated mamillæ succeed the latter, each being furnished with a row of short hooks, which differ entirely from the foregoing (Plate XVI. fig. 7 *a*). Each has a short and wide basal process, a

* Nord. Hafs-Annulat. p. 395, tab. xxiv. fig. 65.

characteristic notch between this and the large beak, and numerous curved fangs of smaller size above the latter. The fangs above the larger beak are not simply arranged in a linear manner, but, as it were, form a spined knob, with the points curved obliquely downwards. The ventral surface of the annelid is marked by a central blood-vessel, and in spirit thrown into prominent transverse rugæ. In my specimens the posterior part of the body tapered to a blunt tail, terminated by two soft papillæ; but these represented the ordinary processes, and probably the tail was absent. The peritoneal bodies are of a pale-red colour, and, as usual in such animals, very large. Dr MALMGREN describes the posterior hooks as bidentate, but does not figure them. If this remark is accurate, then the foregoing differs specifically.

EXPLANATION OF THE PLATES.

The following letters have been employed as far as possible in designating similar organs in Ommatoplea and allies.

a. Proboscis
ac. Reflection of proboscis in front of ganglia.
b. Epidermis.
ab. Channel in snout for proboscis.
c. Cutis.
d. Circular muscular coat.
e. Longitudinal muscular coat.
f. Superior commissure of ganglia.
g. Inferior commissure of ganglia.
h. Superior lobe of ganglion.
i. Inferior lobe of do.
j. Œsophageal apparatus.
j'. Digestive canal-proper.
k. General stroma of snout.
l. Cephalic vessel.
m. Cephalic sac.
m'. Duct of do.
n. Great lateral nerve-trunk.
o. Proboscidian sheath.
p. Dorsal blood-vessel.
q. Anastomotic branch.
r. Lateral blood-vessel.
ov. Ova *in situ.*
v. Lateral stylet-sacs.
z. Anus.

A. First region of proboscis.
B. Second do. do.
C. Third do. do.
ϵ. Globule in lateral stylet-sac.
β. Stylets in do.
δ. Duct of lateral stylet-sac.
ε. Muscular chamber behind the floor of the anterior region of proboscis.
η. Floor of anterior chamber of proboscis.
θ. Muscular setting of granular basal apparatus.
λ. Granular basal sac.
μ. Ejaculatory duct.
μ'. Aperture of ejaculatory duct into chamber ε.
π. External granular glands.
ρ. Reservoir.
σ. Glands of reservoir.
τ. Looping muscular fibres of the walls of reservoir.
το. Longitudinal muscular fibres of the walls of reservoir.
φ. Duct of communication with the posterior chamber.
χ. Wall of posterior chamber.
ψ. Muscular ribbons.

Letters used to designate similar parts in Borlasia and Cephalothrix.

a. Proboscis.
ao. Tube for proboscis in snout.
b. Cephalic fissures.
c. Ciliated epidermis.
d. External layer of cutis.
d'. Basement-layer.
d''. Pigment-layer in *B. olivacea.*
e. External (longitudinal) layer.
e'. Circular muscular layer.
e''. Inner (longitudinal) muscular layer.

f. Superior ganglionic commissure.
g. Inferior do. do.
h. Ganglia.
h'. Superior lobe of ganglion.
h''. Inferior lobe of do.
j. Œsophageal region.
j'. Alimentary cavity-proper.
k. General stroma of cephalic region.
m. Cephalic sacs.
m'. Ducts of cephalic sacs.
n. Great lateral nerves.
o. Proboscidian sheath.
p. Dorsal blood-vessel.
r. Lateral blood-vessel.
s. Lacunæ behind ganglia.
u. Vascular meshes around the œsophageal region.
v. Larger vascular cavity at each side of the sheath for the proboscis in front.
w. Mouth.
y. Constriction marking the junction of the œsophageal region with the digestive cavity-proper.
z. Anus.
ov. Ovaries and their remains.
⚓. Muscular ribbons of proboscis.

Plate IV.

Fig. 1. Transverse section, a short distance behind the tip of the snout of *Ommatoplea alba*, 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 diameters.

... 2. Transverse section of the body-wall of *O. alba*, after hardening in spirit and mounting in chloride of calcium; *a*, cutis, with its cells and areolæ, somewhat compressed; *b*, structureless basement-layer; *c*, circular muscular coat; *d*, longitudinal muscular coat; *e*, delicate fibres proceeding from the latter to the viscera. × 700 diameters.

... 3. View of a portion of skin snipped from a living specimen, and submitted to moderate pressure. × 350 diameters.

... 4. Longitudinal section of the anterior region of the proboscis of *O. alba*. The same letters are used as in fig. 4, Pl. V. × 90 diameters.

... 5. Transverse section through the anterior part of the cephalic ganglia, in a specimen which had been chloroformed 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 diameters. In this and other drawings, accuracy has been preferred to symmetry.

... 6. Section of the snout in front of fig. 1, showing the channel for the proboscis (*a*), and the cephalic blood-vessels (*l*), just before they complete the arch. × 210 diameters.

... 7. Elements as they escape from the fresh skin of the same animal; *a*, granular cells; *b*, mucous or gelatinous masses, having the appearance of oil-globules. × 350 diameters.

... 8. Skin of *O. alba*, as seen near the tail of a small living specimen, under slight compression. × 350 diameters.

... 9. Corpuscles of the proboscidian fluid; *a*, minute nucleated cells and granules; *b*, spindle-shaped corpuscles. × 500 diameters.

... 10. Stylet, from a lateral sac of the same species, showing a "wing" at base (from remains of globule), and an abnormal point. × 210 diameters.

... 11. Discs of proboscidian fluid, from a specimen of *Tetrastemma varicolor*. × 350 diameters.

... 12. Small gregariniform parasite, from the digestive cavity of *Tetrastemma variegatum*. × 210 diameters.

... 13. Proboscidian aperture in snout of *O. alba*. × 210 diameters.

... 14. Discs of proboscidian fluid from *Tetrastemma variegatum*. × 350 diameters.

Plate V.

Fig. 1. Transverse section through the cephalic ganglia of *O. alba*, 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 glandular stroma of the region. × 90 diameters.

Fig. 2. Transverse 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 a 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 at the sides of the œsophagus. × 55 diameters.

... 3. Isolated gland-cells from the posterior chamber of the proboscis. × 350 diameters.

... 4. Transverse section through the anterior region of the proboscis in a large *O. alba*, after hardening in spirit and mounting in chloride of calcium; *a*, central cavity; *b*, the papillary glandular layer; *c*, internal circular muscular coat; *d*, inner longitudinal layer; *e*, peculiar reticulated or beaded layer; *f*, external longitudinal muscular layer; *g*, external layer; *h*, basement-layer. × 90 diameters.

... 5. Transverse section through the stylet-region of the proboscis of the same species, in the line of the lateral sacs. × 350 diameters.

... 6. Glandular papillæ from the proboscis of *Tetrastemma vermiculus*, seen on the free edge of the everted organ. × 700 diameters.

... 7. Glandular papillæ in the anterior region of the proboscis of *O. alba*, seen in the ordinary condition of the organ under pressure. × 210 diameters.

... 8. Portion of the everted inner surface of the posterior chamber of the proboscis of the same species. The glands have for the most part burst and become minutely hirsute. × 350 diameters.

... 9. Portion of the glandular surface of the posterior chamber of the proboscis in its normal condition. × 350 diameters.

... 10. Portion of the inner surface of the same chamber, viewed *in situ* under pressure. The papillæ are hirsute, and their contents scattered over the surface of the organ. × 350 diameters.

... 11. Lanceolate and pedicled papillæ from the anterior part of the proboscis of *T. vermiculus*. × 300 diameters.

... 12. Central stylet of *Ommatoplea purpurea*. × 700 diameters.

... 13. Central stylet and basal apparatus of the same species. × 350 diameters.

... 14. Developing or recently repaired central stylet-apparatus in *T. algæ*. × 700 diameters.

... 15. Stylet from a lateral sac of the same animal. × 700 diameters.

Plate VI.

Fig. 1. Head of *O. alba*. × 210 diameters.

... 2. Proboscis of the same species, gently but completely extruded under chloroform, so as to render the central stylet prominent. × 55 diameters.

... 3. View of the nervous and circulatory systems in the anterior end of *O. alba*.

... 4. Abnormal stylet-region in the same species; *a*, perfect stylet-sac of the left side; *b*, shrivelled sac of the right side. × 210 diameters.

... 5. Stylet-region of the proboscis of *T. varicolor*, with the reservoir somewhat contracted. × 210 diameters.

... 6. Extremity of the posterior chamber of the proboscis in *T. variegatum*, apparently after rupture of the muscular ribands from the sheath of the organ. × 350 diameters.

... 7. Stylet-region in *Ommatoplea melanocephala*. × 90 diameters.

... 8. Circulation, &c., in the posterior end of *O. alba*; a fragment of the same drawing from which fig. 3 was cut.

... 9. Isolated lateral stylet-sac of *O. alba*; *a*, a few 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 diameters.

... 10. Tip of the snout of *Borlasia olivacea*, with proboscis partly protruded. × 210 diameters.

... 11. Central stylet-apparatus in *Ommatoplea pulchra*; *a*, central stylet; *b*, reserve-stylet *in situ*. × 210 diameters.

... 12. Central stylet and its basal granular apparatus in *O. gracilis*, turned round so as to demonstrate the curvature of both. × 100 diameters.

... 13. Isolated central stylet of the foregoing. × 420 diameters.

Plate VII.

Fig. 1. Stylet-region of the proboscis of *O. gracilis.* × 210 diameters.
... 2. Stylet-region of the proboscis of *O. purpurea.* × 210 diameters.
... 3. Stylet-region of the proboscis of *O pulchra.* × 90 diameters.
... 4. Extremity of the posterior region of the proboscis of *O. alba* distended with fluid; *a,* a group of the peculiar dancing granules. × 90 diameters.
... 5. Stylet-region of the proboscis of *Polia involuta,* Van Beneden. × 700 diameters.
... 6. Stylet-region of the proboscis of a young *O. alba,* 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 animal. × 700 diameters.
... 7. Fragment of the œsophagus from a living animal; *a,* inner edge of ciliated fold; *b,* sulcus between two folds. × 350 diameters.
... 8. Eye of *Ommatoplea pulchra.* × 210 diameters.
... 9. Central stylet and portion of basal apparatus in a large *O. gracilis.* × 350 diameters.
... 10. Transverse section of an everted proboscis in a small specimen of *O. pulchra.* The papillose mucous surface has been injured in the manipulation. × 90 diameters.
... 11. Nerve-cells from a cephalic ganglion of *O. alba.* × 400 diameters.
... 12. Portion of a sperm-sac in *Tetrastemma varicolor,* showing a streaked and granular aspect, from the varying nature of the contents. × 350 diameters.

Plate VIII.

Fig. 1. Aspect of the developing proboscis in *O. melanocephala,* about the fifth day after the removal of the original organ. × 55 diameters.
... 2. Stylet-region of a developing proboscis in the same species; *f,* canal, which by-and-by is occupied by the central stylet. The organ is contracted. × 350 diameters.
... 3. Anterior region of *Tetrastemma algæ,* showing the arrangement of the digestive system. Enlarged.
... 4. Termination of the posterior chamber of the proboscis (C) in *O. alba,* with muscular ribands. × 210 diameters.
... 5. Head and anterior portion of *Polia involuta,* V. Ben.; *f,* powerful transverse band of fibres which retains the posterior part of the œsophagus *in situ.* × 180 diameters.
... 6. The central (*a*) and lateral stylets (*b*) from a young *O. alba,* on the first appearance of the former. × 700 diameters.
... 7. Cephalic ganglia of *Tetrastemma varicolor.* × 210 diameters.
... 8. Unimpregnated ovum of *O. alba;* *a,* outer coat; *b,* inner coat; *c,* vitellus; *d,* "micropyle," or cicatrix-like arrangement. × 90 diameters.
... 9. Ovum of *O. gracilis* after impregnation; *a,* outer coat; *b,* inner coat; *c,* vitellus. × 90 diameters.
... 10. The inner coat and vitellus of an ovum (of *O. gracilis*) at the same stage of development, with the relations of the spermatozoa. × 210 diameters.
... 11. Ovum of *O. alba,* just before the extrusion of the embryo. × 90 diameters.
... 12. Spermatozoa of *Tetrastemma vermiculus.* × 1000 diameters.
... 13. Spermatozoa of *O. alba.* × 800 diameters.
... 14. Spermatozoa of *T. variegatum.* × 400 diameters.

Plate IX.

Fig. 1. Young *O. alba,* on extrusion from the egg, somewhat compressed. × 55 diameters.
... 2. Young *O. alba* eight days older than the preceding; *b,* stylet-region; *c,* point where the posterior chamber of the proboscis becomes lost, after curving forwards. × 90 diameters.
... 3. Structure of the stylet- and reservoir-regions in *O. alba.* Considerably magnified.
... 4. View of the cutis in a living specimen of *Borlasia olivacea* as a transparent object. × 210 diameters.
... 5. Streaked arrangement of the cutis of *B. olivacea,* from the dorsum. × 210 diameters.
... 6. Pigment-cells from the anterior part of the dorsum of the same species. × 350 diameters.
... 7. View of the skin of a living *Meckelia annulata.* × 350 diameters.
... 8. Spermatozoa of *Ommatoplea gracilis.* × 700 diameters.
... 9. Spermatozoa of *Polia involuta.* × 950 diameters.

Fig. 10. Transverse section through the contracted reservoir-region of *O. alba*, showing the complex spiral arrangement of the fibres. × 55 diameters.
... 11. Superficial structure of the reservoir- and stylet-regions in the same species.
... 12. Central stylet and basal apparatus with radiating fibres in *Tetrastemma vermiculus*. × 350 diameters.
... 13. Stylet-region of a young *O. alba*, some weeks older than that represented in fig. 2. × 350 diameters.
... 14. Transverse section through the posterior chamber of the proboscis in a large example of *O. alba*. The circular and longitudinal muscular and the mucous coats are well shown. × 90 diameters.
... 15. Young *Tetrastemma variegatum*, shortly after extrusion from the egg, and somewhat compressed, so as to show its cellulo-granular structure. × 350 diameters.
... 16. Portion of the long posterior chamber of the proboscis of *O. purpurea*, showing the characteristic plaits of the mucous surface. × 90 diameters.

Plate X.

Fig. 1. Enlarged view of the anterior end of *B. olivacea* as a transparent object.
... 2. Transverse section through the curious example (probably a variety of *Meckelia*) from Balta; *d*, external layer of cutis; *d'*, basement-layer; *e*, longitudinal muscular layer; *ea*, dorsal sub-divisions of the latter coat in the central line; *e'*, circular muscular coat; *j*, section of the œsophageal region of the digestive tract; *ja*, distinct band of muscular fibres enclosing the latter; *n*, lateral nerve; *o*, sheath for proboscis; *r*, vascular spaces. × 55 diameters.
... 3. Transverse section through the body of *Cephalothrix filiformis*. The proboscis is coiled in its sheath. × 90 diameters.
... 4. Transverse section just behind the tip of the snout of *Borlasia olivacea*. 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 leading to proboscis, and which radiate into the surrounding stroma (*k*). × 55 diameters.
... 5. Portions of the inner surface of the proboscis of the same species, showing the glandular papillæ, slightly compressed. × 700 diameters.
... 6. Gland-cells from the wall of the digestive cavity of *Ommatoplea alba*. × 400 diameters.
... 7. One of the same slightly compressed glands. × 700 diameters.
... 8. Contents of the same gland-cells, with oil-globules. × 700 diameters.
... 9. Spermatozoa of *Borlasia olivacea*. × 700 diameters.

Plate XI.

Fig. 1. Transverse section through *Borlasia olivacea*, just at the commencement of the œsophageal region; 2, radiated or slightly arborescent arrangement of the external longitudinal muscular coat at the sides of the mouth. The thick folds of the œsophagus are seen almost at the termination of the anterior cul-de-sac. × 90 diameters.
... 2. Arrangement of the ova in the ovisacs of *Tetrastemma vermiculus*; *a*, proboscis; *o*, proboscidian sheath. Only a fragment of the body is represented. × 24 diameters.
... 3. Spermatozoa of *Cephalothrix filiformis*. × 900 diameters.
... 4. Spermatozoa of *Lineus longissimus*. × 900 diameters.
... 5. Spermatozoa of *Borlasia octoculata*. × 800 diameters.
... 6. Transverse section through the body-wall of *Lineus longissimus* 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 somewhat regular spaces. Other letters as usual. × 210 diameters.
... 7. Longitudinal section of the tissues of the body-wall in the same species; 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 diameters.
... 8. Transverse section of the body-wall of *Borlasia olivacea*. × 350 diameters.
... 9. Proboscis of *Cephalothrix filiformis*, slightly everted, so as to exhibit the acicular papillæ. × 350 diameters.

Fig. 10. Aggregations of fatty granules from the discarded coating of the embryo of *B. olivacea*. × 210 diameters.

Plate XII.

Fig. 1. Transverse section through the proboscis of a Borlasian (*Micrura*) from St Andrews; *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*, separated segment at the other pole of the circle. × 90 diameters.

... 2. Transverse section of the snout of *Borlasia olivacea*, somewhat behind that shown in fig. 4. Pl. X., 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 diameters.

... 3. Transverse section of a specimen of *B. olivacea*, in which the ova are well developed. The shrunken condition of the walls of the digestive cavity (*j'*), with the numerous array of gregariniform parasites, is in strong contrast with the state of the animal after spawning. The specimen had been in spirit for a considerable time before dissection. × 55 diameters.

... 4. 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 diameters.

... 5. The foregoing parasite in an earlier state of development. × 350 diameters.

... 6. The last-mentioned specimen subjected to slight pressure, so as to exhibit the segments. × 350 diameters.

... 7. Posterior end of a young *B. olivacea*, showing the anal papilla. × 210 diameters.

... 8. Transverse section through the post-ganglionic region of *Lineus lactea*, Mont. MS., 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 diameters.

... 9. Stylet-region in *Tetrastemma variegatum*, somewhat contracted, and with the floor of the anterior chamber pouted forwards. The latter condition is more easily seen in *Tetrastemma* than in *O. alba*. × 210 diameters.

... 10. Fragment of the wall of the digestive chamber-proper, from the living *Borlasia olivacea*. The cilia mark the inner surface. × 350 diameters.

... 11. Cells from the digestive cavity of a young *Cephalothrix filiformis*. × 700 diameters.

... 12. One of the pinnate processes of the scale of *Sthenelais dendrolepis*, Clap. × 90 diameters.

Plate XIII.

Fig. 1. Highly magnified view of the anterior end of *Cephalothrix filiformis* (Astemma); *b*, *b*, bridles of sheath for proboscis.

... 2. Arrangement of the vessels at the posterior extremity of *Borlasia olivacea*. Magnified.

... 3. Ovum of *Cephalothrix filiformis* immediately after deposition. × 350 diameters.

... 4. Flask from the mucous cord of *B. olivacea*, with 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 diameters.

... 5. Young *B. olivacea* immediately after leaving the flask-shaped capsule; *b*, opening of the cephalic sac of the right side. The other letters as in the adult. × 90 diameters.

... 6. Transverse section through the middle of *B. olivacea* after the second or great region of the digestive cavity has attained its full size. The difference between such a view and the indistinct mass formed by the Ommatoplean digestive cavity, after section, is characteristic. × 55 diameters.

... 7. Cellular elements of the wall of the digestive chamber of the same species. × 700 diameters.

... 8. Pale oily region with germinal vesicle (*a*), and germinal dot (*b*), in an ovum removed from the body of the female *B. olivacea*. × 350 diameters.

... 9. Elements of the glandular papillæ of the proboscis of *B. olivacea*, after their escape into the surrounding water. × 700 diameters.

Fig. 10. } Hooks of *Amage*. × 700 diameters.
... 10 *a*. }

PLATE XIV.

Fig. 1. Ovum of *Polia involuta*, VAN BEN., immediately after deposition. × 350 diameters.
... 2. Ovum of the same species about the 10th day, showing the ciliated embryo revolving therein. × 350 diameters.
... 3. Young of *Cephalothrix filiformis* shortly after extrusion from the egg. × 350 diameters.
... 4. A young specimen of *Cephalothrix*, two days older than that shown in fig. 3; *a*, mouth; *b*, granules of digestive cavity. × 210 diameters.
... 5. A specimen about three days older than the foregoing (fig. 4). × 210 diameters.
... 6. Young *Polia involuta*, extruded from the body of the adult under pressure. It has the same appearance when originating in a free ovum. × 350 diameters.
... 7. Young *C. filiformis*, after shedding the long anterior whip of cilia, but having the lateral tufts (*c*) and eyes; *a*, mouth; *b*, granules of digestive cavity. × 210 diameters.
... 8. Transverse section through the proboscis of *Lineus longissimus*. × 55 diameters.
... 9. Magnified view of the ganglionic region of a large *Ommatoplea alba*, in which a parasitic ovum (*y*) lay imbedded in a granular lobulated mass (*y'*).
... 10. Parasite extruded from 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.
... 11. Transverse section through the body of a large *Meckelia annulata*. × 55 diameters.
... 12. Head and proboscis (*a*) of a remarkable variety of *Meckelia*, brought from Shetland (Balta) by Mr Gwyn Jeffreys; *b*, curiously frilled arrangement of the enlarged homologue of the superior lip of the cephalic fissure; *w*, prolapsus of textures from mouth. Magnified under a lens.
... 13. Hook of *Ampharete artica*, MGRN. × 700 diameters.
... 14. Hook of *Amphicteis gunneri*. × 700 diameters.
... 15. Hook of *Terebella*, from the Hebrides. × 700 diameters.

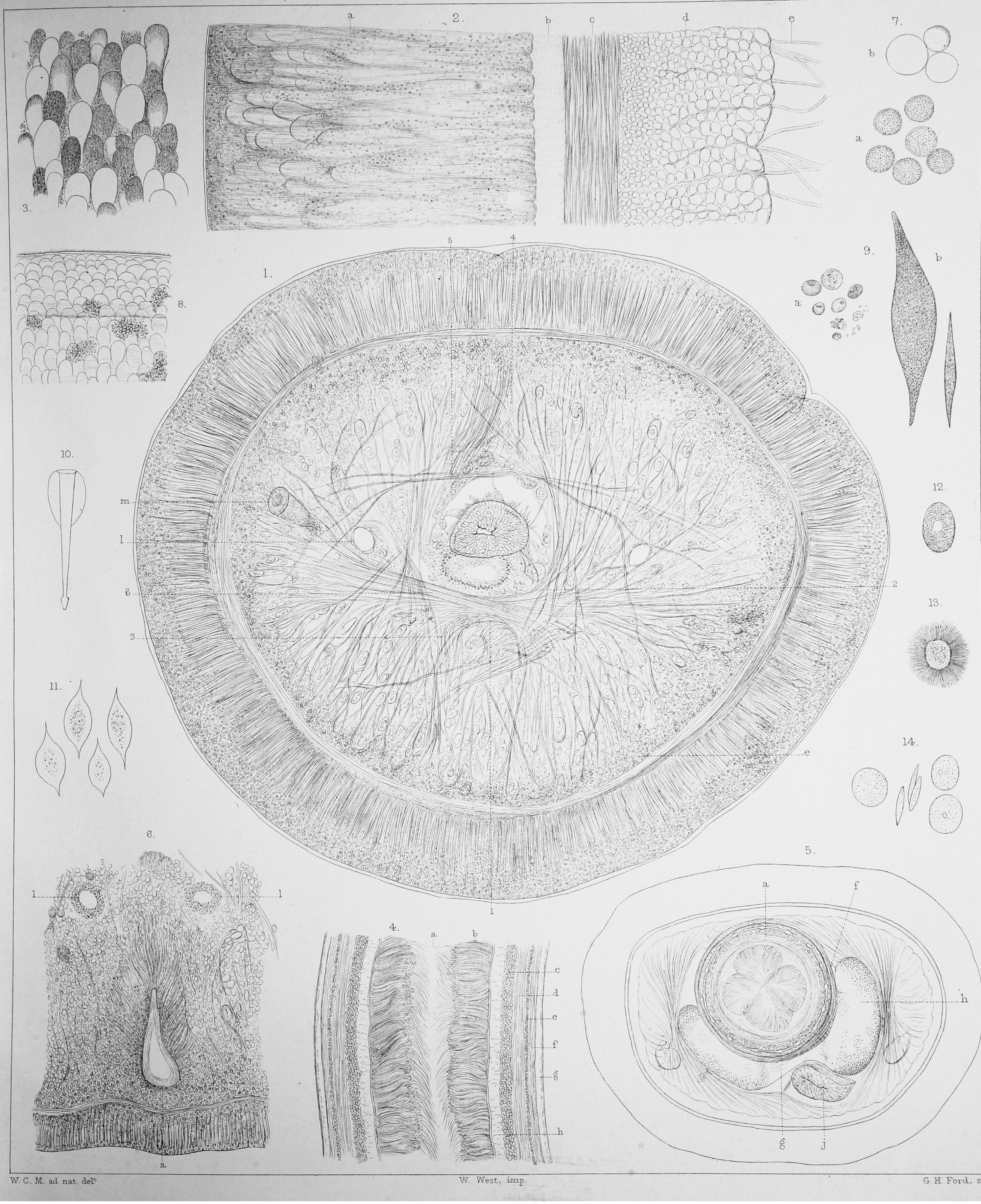
PLATE XV.

Fig. 1. Bristles of *Amphinome vagans*; *a*, bristle from the inferior lobe of foot; *b*, *c*, bristles of the superior lobe. × 700 diameters.
... 2 *a*. Dorsal bristle of *Lepidonotus pellucidus*, EHLERS. × 700 diameters.
... 2 *b*. Ventral bristle of the same species. × 700 diameters.
... 3. Ventral bristle of *Polynöe longisetis*, GRUBE. × 350 diameters.
... 3 *a*. Tip of the dorsal cirrus of the same species. × 55 diameters.
... 4. } Two of the characteristic bristles (with jointed tips) of *Sthenelais dendrolepis*, CLAP.
... 5. } × 350 diameters.
... 6. }
... 6 *a*. } Ventral bristles of *Halosydna gelatinosa*, SARS. × 180 diameters.
... 6 *b*. }
... 7. Ventral bristle of *Ophiodromus vittatus*, SARS., with short terminal process. × 700 diameters.
... 8. Fragment of a bristle from the dorsal lobe of the same animal. × 700 diameters.
... 9. Bristle of *Notophyllum polynoides*, ŒRST. × 420 diameters.
... 9 *a*. Lateral view of the end of the shaft and its processes in the same bristle. × 700 diameters.
... 9 *b*. Profile view of the same. × 700 diameters.
... 10. Bristles of the littoral form of *Sphærosyllis hystrix*, CLAPARÈDE; *a*, simple spine; *b*, jointed bristle. × 700 diameters.
... 11. Jointed bristles of *Autolytus pictus*, EHLERS. × 700 diameters.
... 12. Bristle of *Syllis*, resembling *S. macrocera*, GRUBE. × 700 diameters.
... 13 *a*. Fragment of the frontal bristle (of *Siphonostoma buskii*) represented in fig. 4 *a*, Pl. XVI. × 350 diameters.
... 13 *b*. Piece of a corresponding bristle from *Trophonia glauca*, MALMGREN. × 350 diameters.
... 14. Hook from the rasp-like surface of *Ammochares ottonis*, GRUBE. × 900 diameters.
... 15. Hook of *Terebella zostericola*, ŒRST. × 700 diameters.

Fig. 16. Hook of *Rhodine loveni*, MGRN. × 700 diameters.
... 17. Hook of a species allied to *Ereutho smitti*, MGRN. × 900 diameters.
... 18 }
... 19 } Hooks of a form closely resembling *Polycirrus aurantiacus*, GRUBE. × 900 diameters.
... 20. Hook of *Pista cristata*, MÜLLER. × 700 diameters.
... 21. Bristles of *Syllis tubifex* (?), GOSSE; *a*, *a*, from middle of body; *b*, spine; *c*, bristle from the third foot. × 280 diameters.

PLATE XVI.

Fig. 1. Ventral bristle of *Castalia punctata*, MÜLL. × 700 diameters.
... 2. Bristle of *Psamathe fusca*, JOHNST. × 700 diameters.
... 3. Jointed hook from the anterior segments of *Hyalinœcia sicula*, QUATREF. × 700 diameters.
... 3 *b*. Simple hook from the posterior region of the same. × 700 diameters.
... 3 *c*. Bristle of the foregoing species. × 700 diameters.
... 4. Hook of *Siphonostoma buskii*, n. sp. × 350 diameters.
... 4 *a*. Bristle from the frontal series of the same species. × 90 diameters.
... 5. Forked bristle of *Eumenia jeffreysii*, n. sp. × 700 diameters.
... 6. Hook from the bristle-bearing segments of *Trichobranchus glacialis*, MGRN. × 90 diameters.
... 7. The same. × 700 diameters.
... 7 *a*. Hooks from the posterior segments of the same annelid. × 700 diameters.
... 8. Bristle of *T. glacialis*. × 350 diameters.
... 9. Bristle of *Sphærosyllis* from the Minch. × 700 diameters.
... 10. Bristle of *Pionosyllis malmgreni*, n. sp. × 700 diameters.
... 11. Foot of *Staurocephalus kefersteini*, n. sp.; *f*, superior cirrus; *g*, inferior cirrus. × 210 diameters.
... 11 *a*.
... 11 *b*.
... 11 *c*.
... 11 *d*. } The varieties of the bristles in the same species, as described in the text. × 700 diameters.
... 12. Hook of *Clymene ebiensis*, AUD. & ED. × 350 diameters.
... 13. Hook of *Praxilla* (*artica ?* MGRN). × 350 diameters.
... 14. Bristle of *Syllis krohnii*, EHLERS. × 700 diameters.
... 15 *a*.
... 15 *b*. } Bristles of *Syllis cornuta*, RATHKE. × 700 diameters.
... 16 *a*.
... 16 *b*. } Hooks of *Sabellides sexcirrata*, SARS. × 700 diameters.
... 17. Foot of *Notocirrus scoticus*, n. sp.; *a*, branchial lobe; *b*, spine; *c*, bristles. × 350 diameters.



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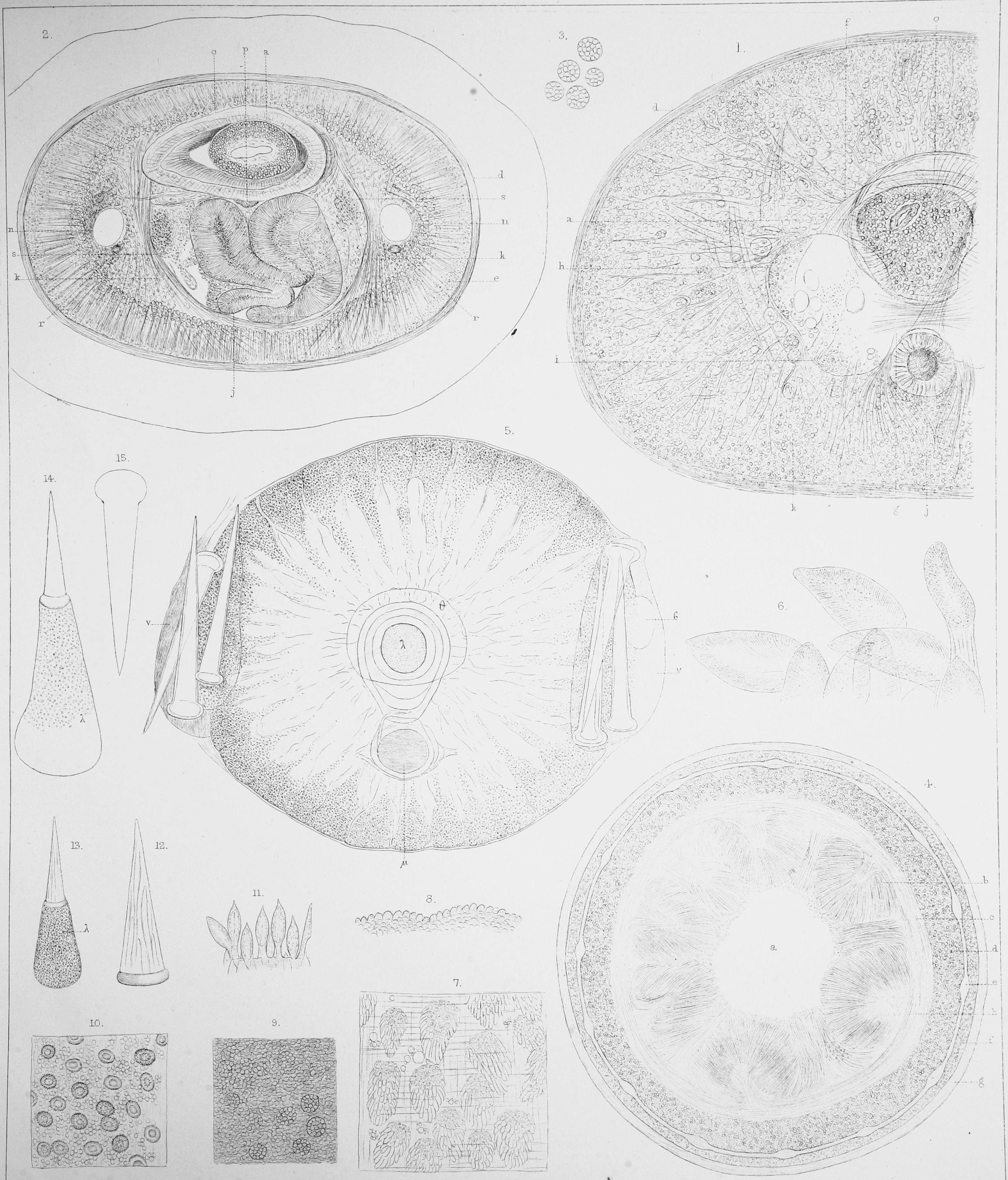

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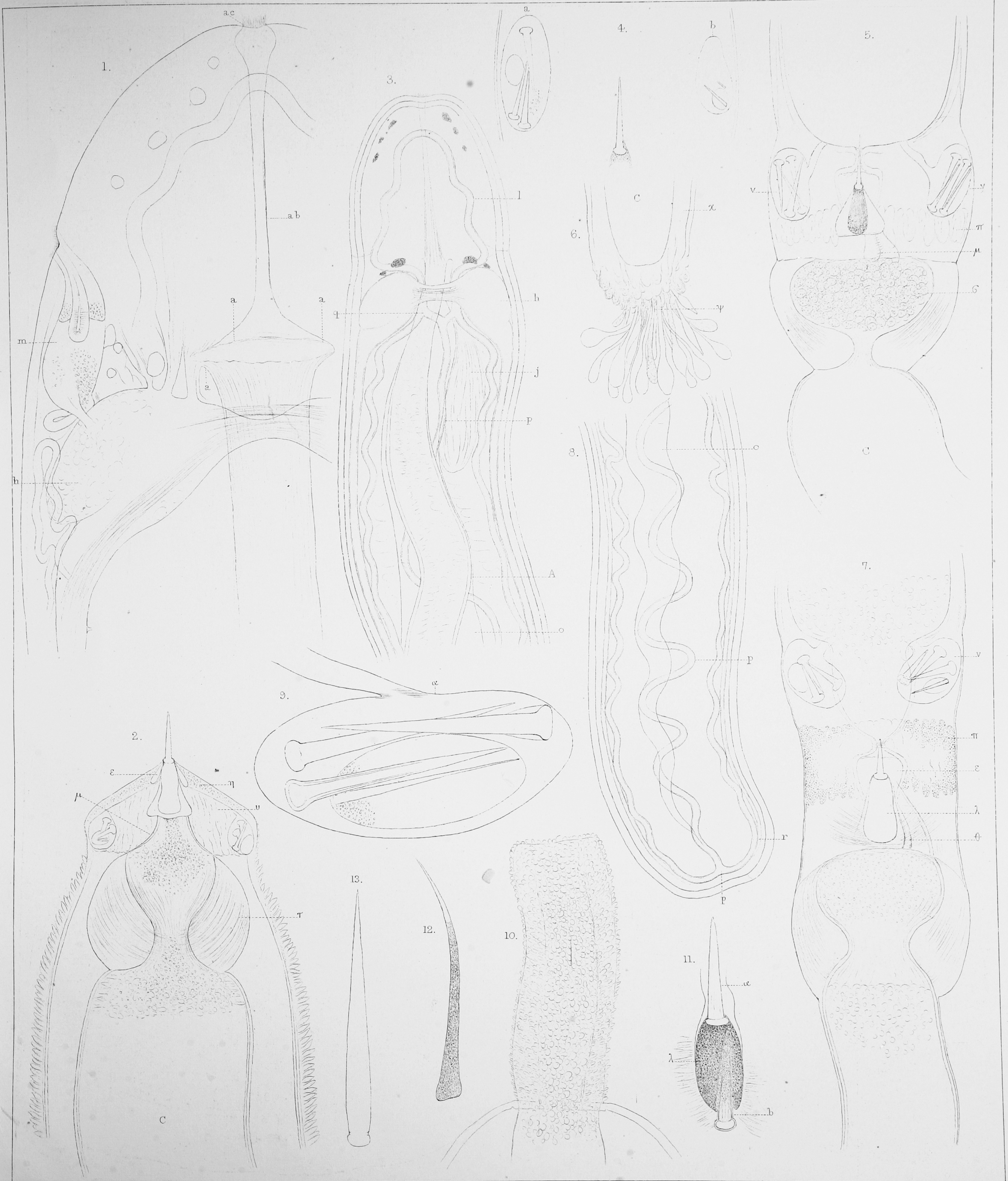

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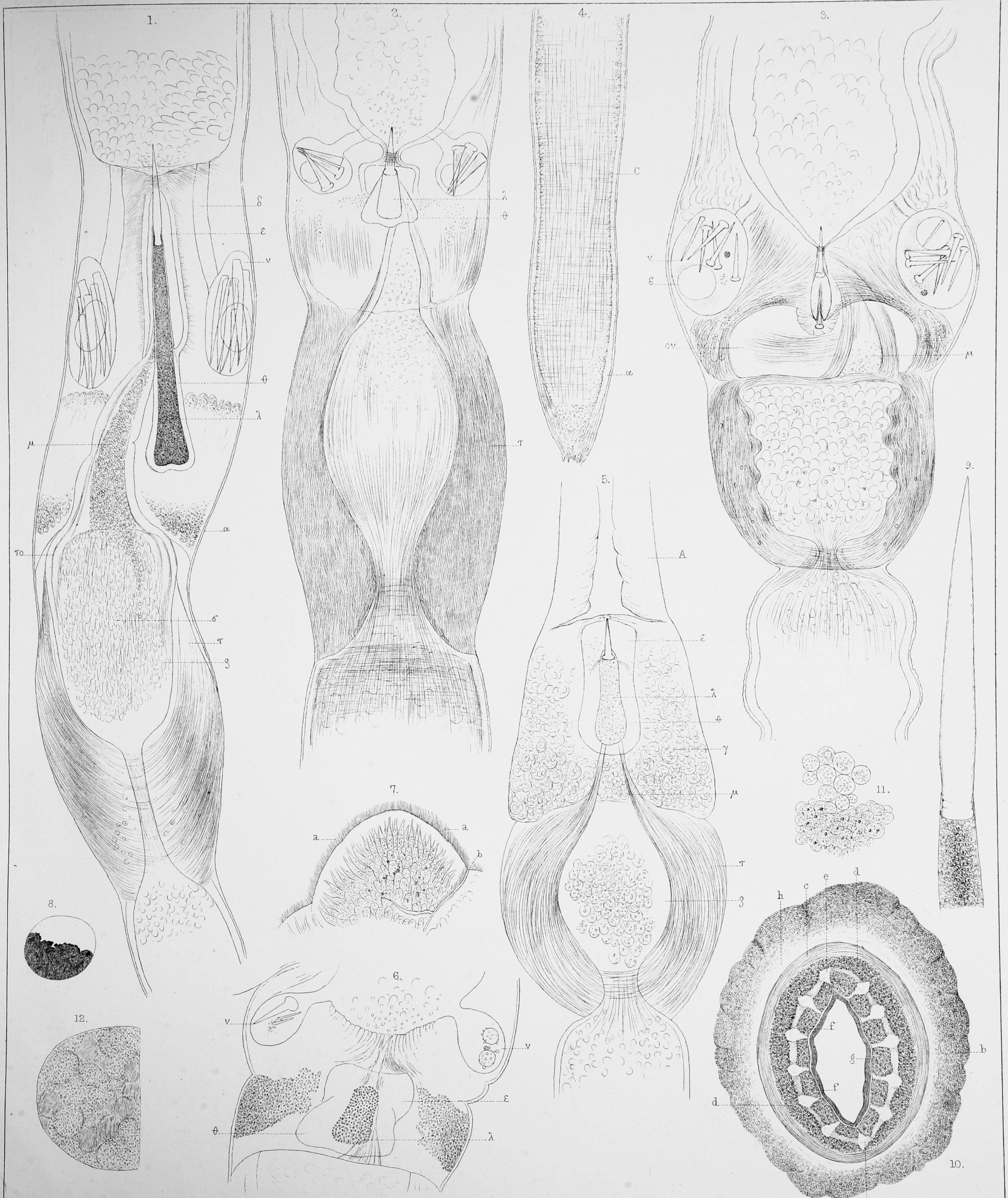

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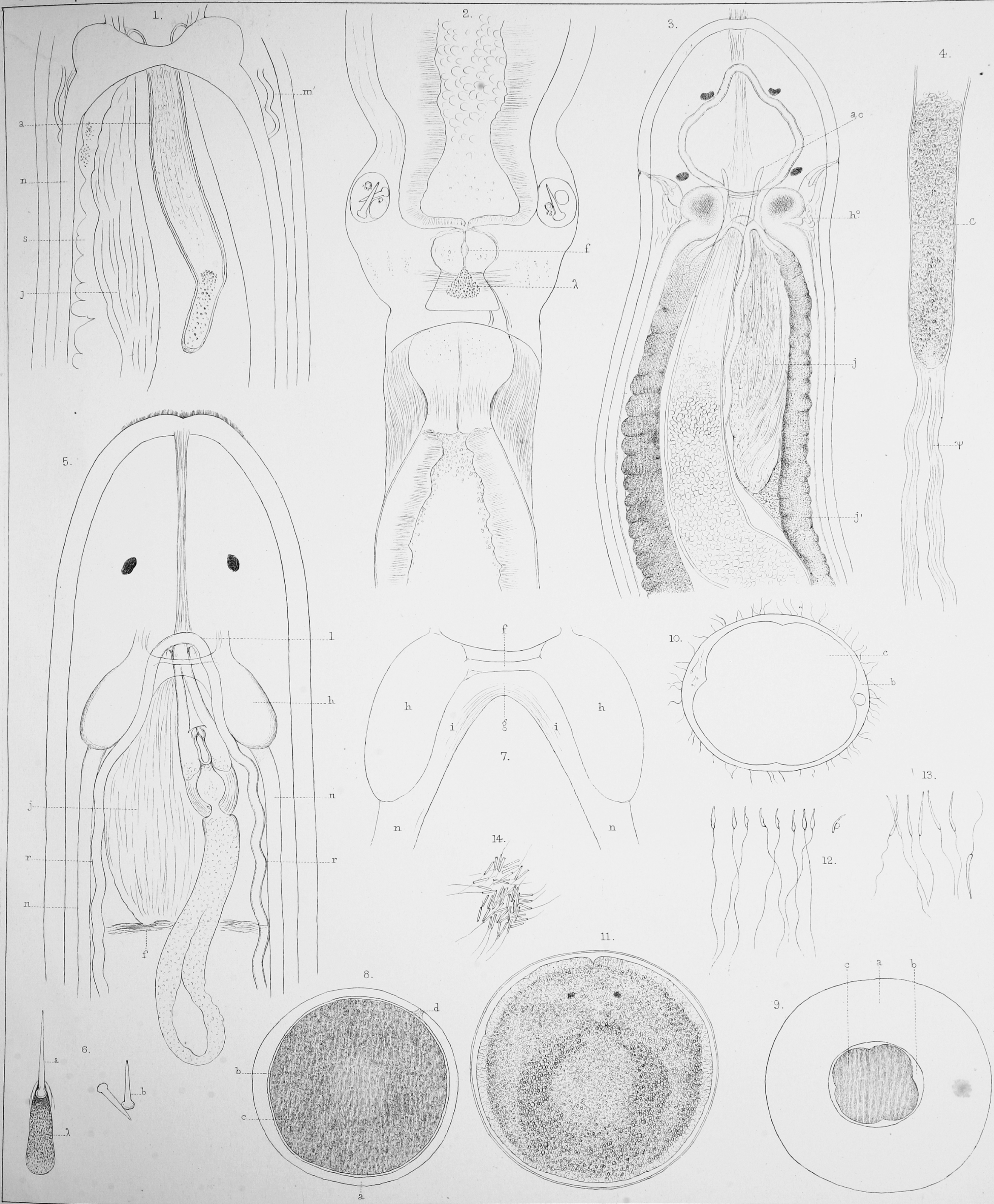

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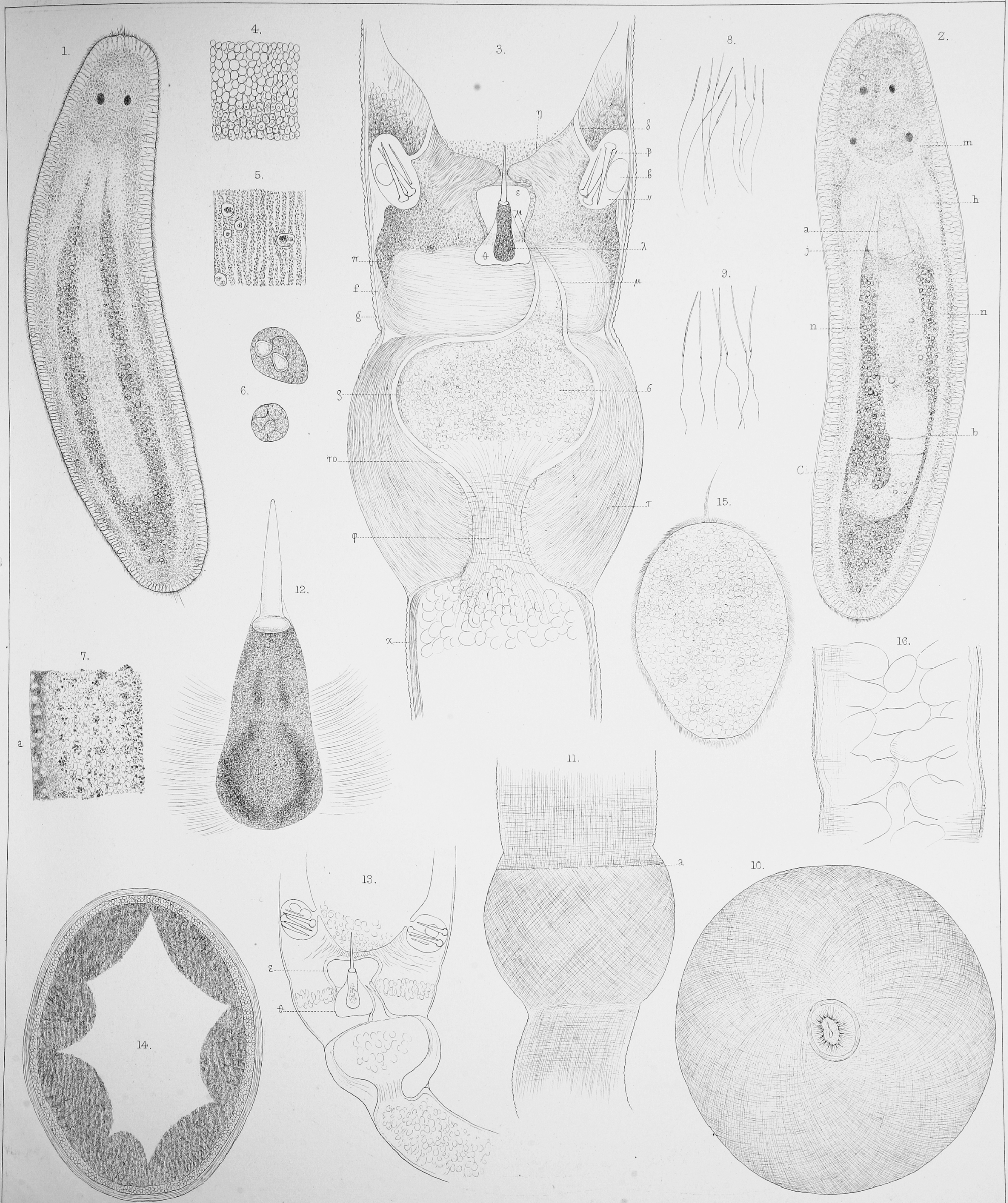

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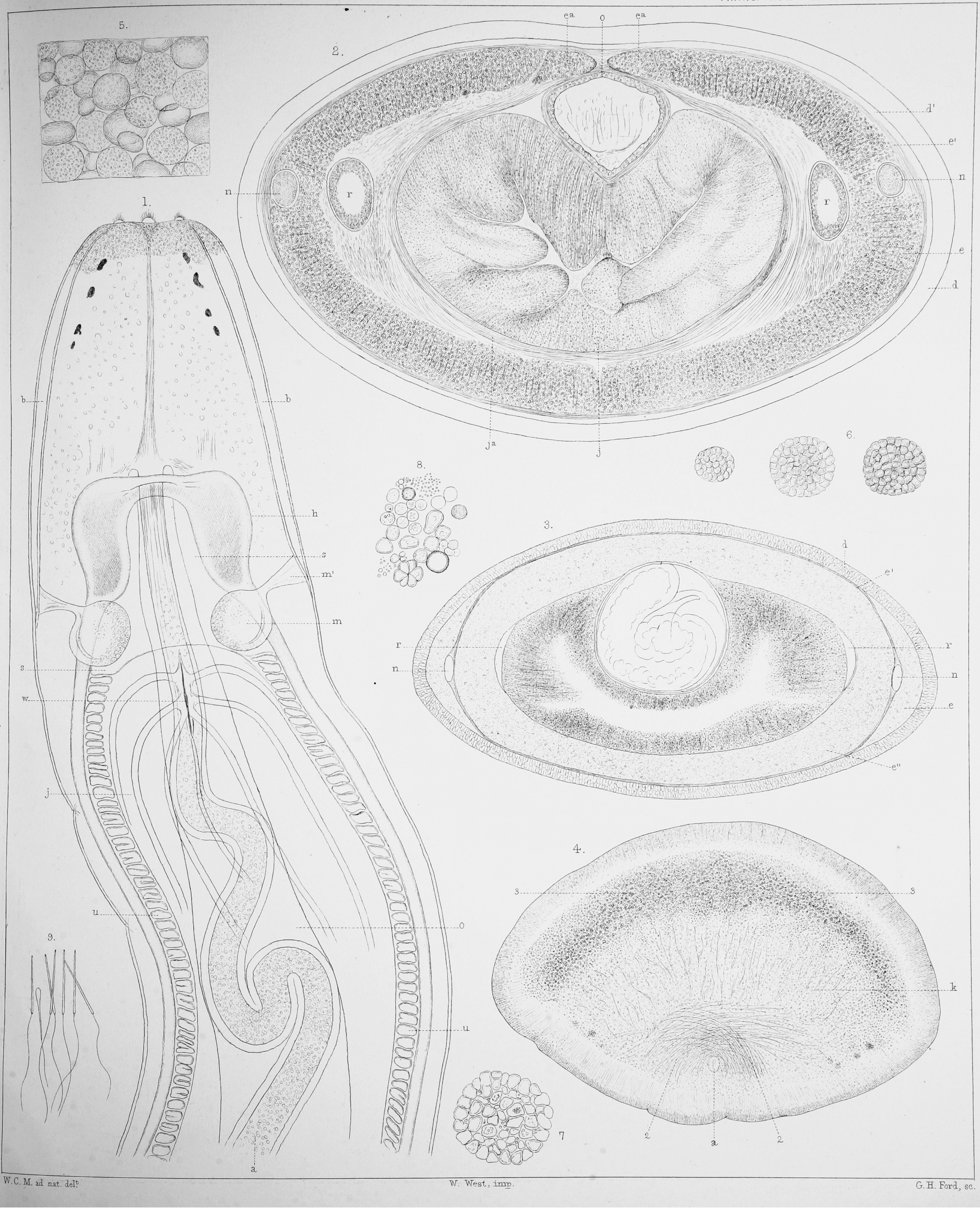

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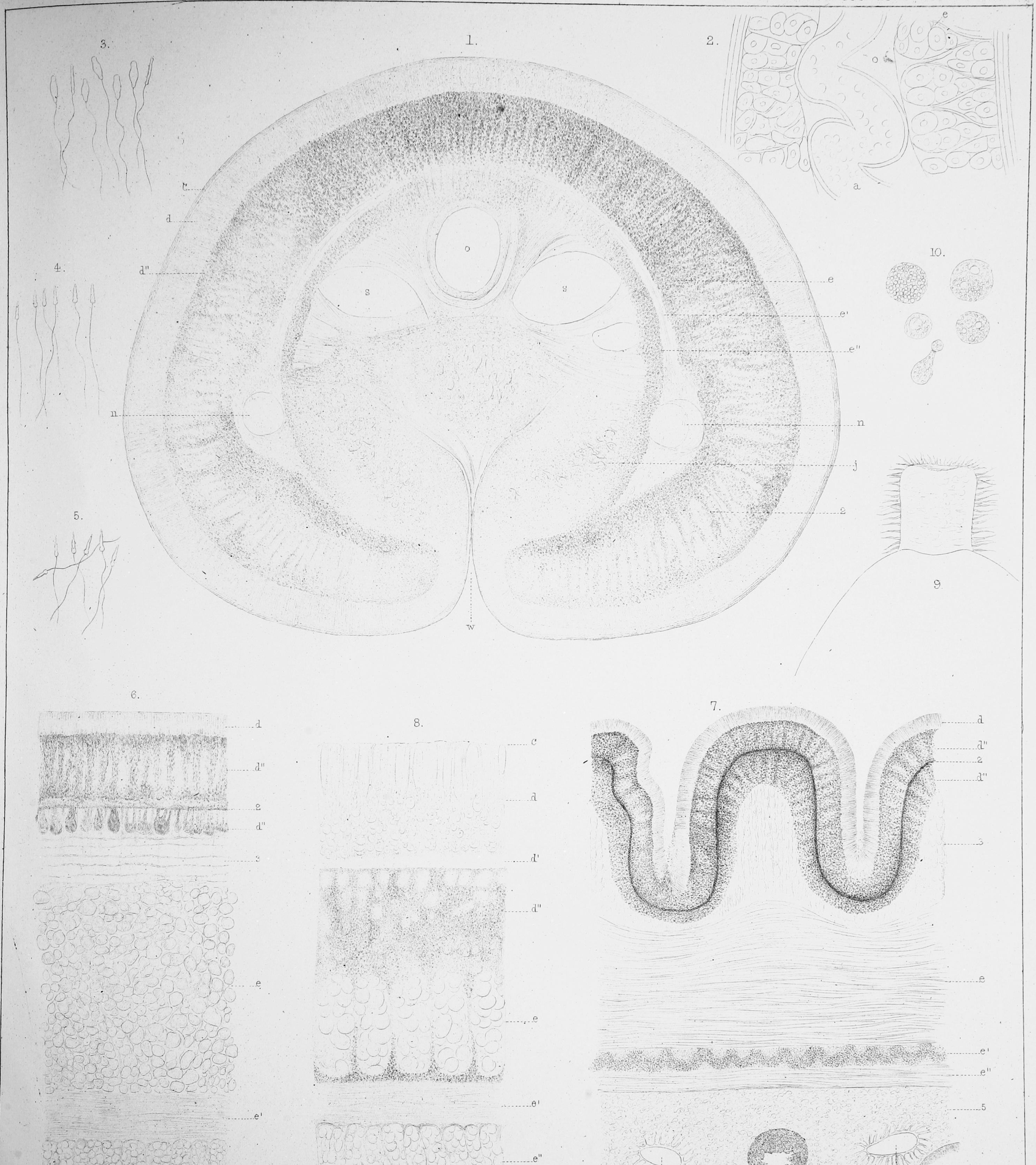

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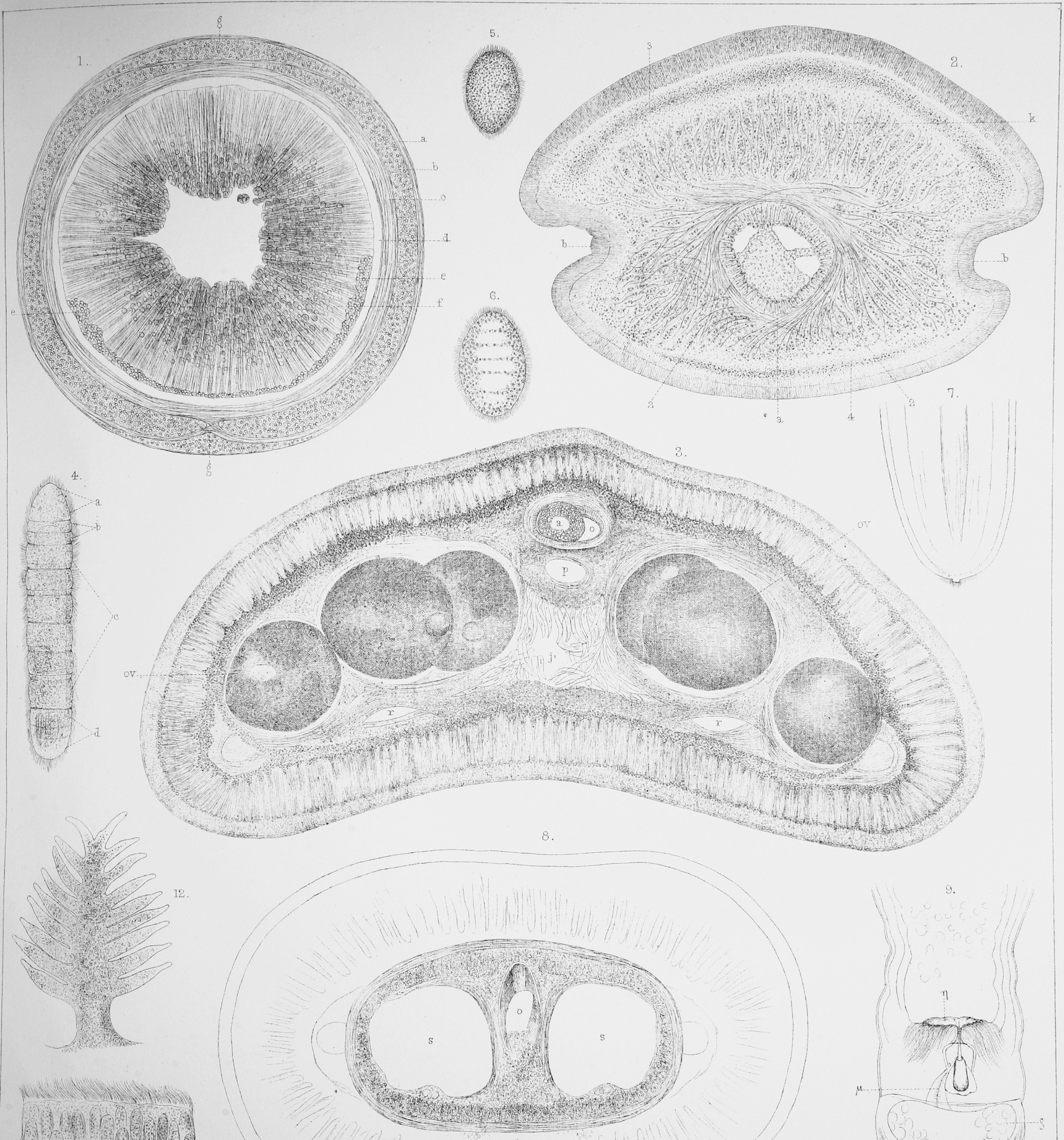

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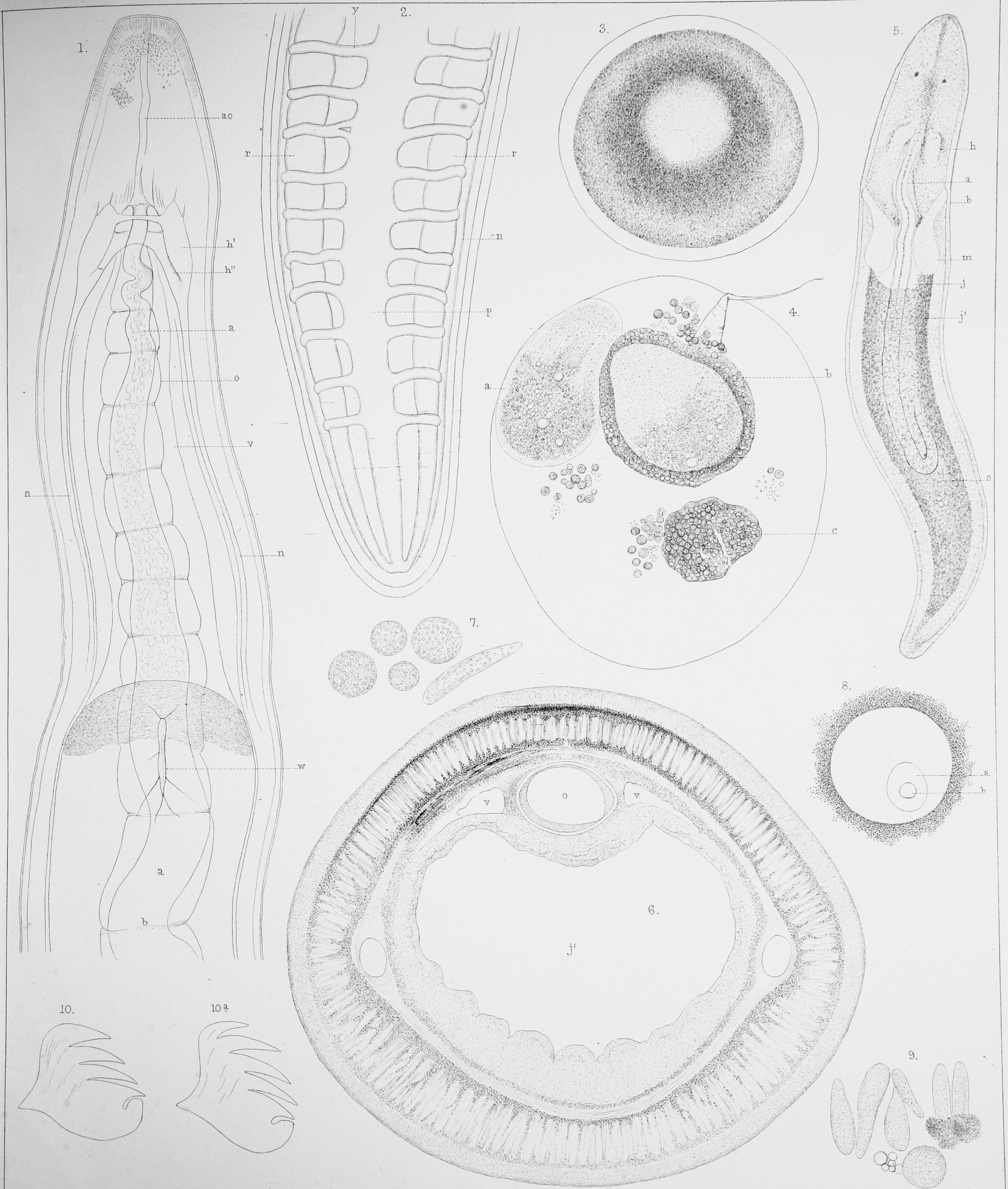

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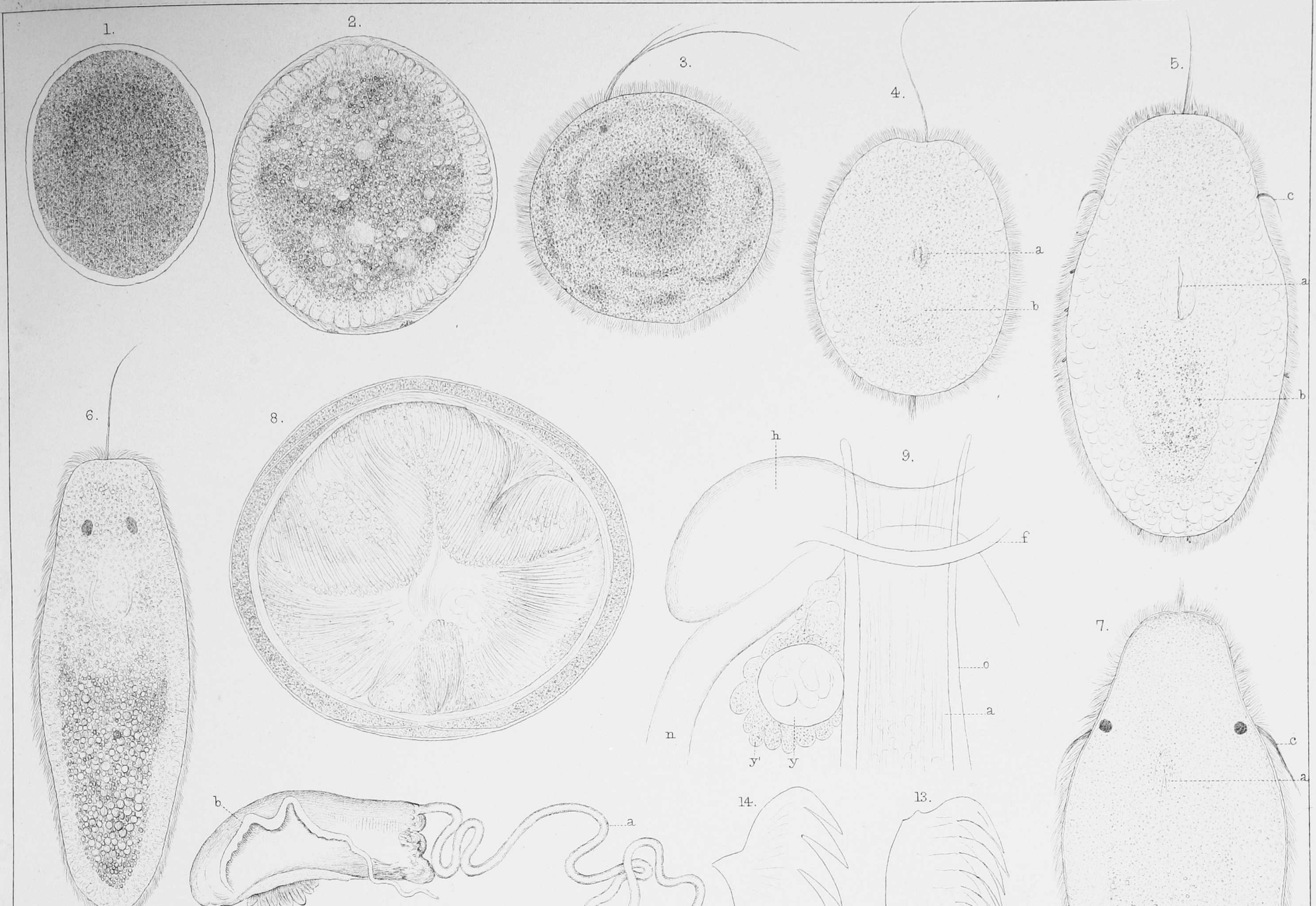

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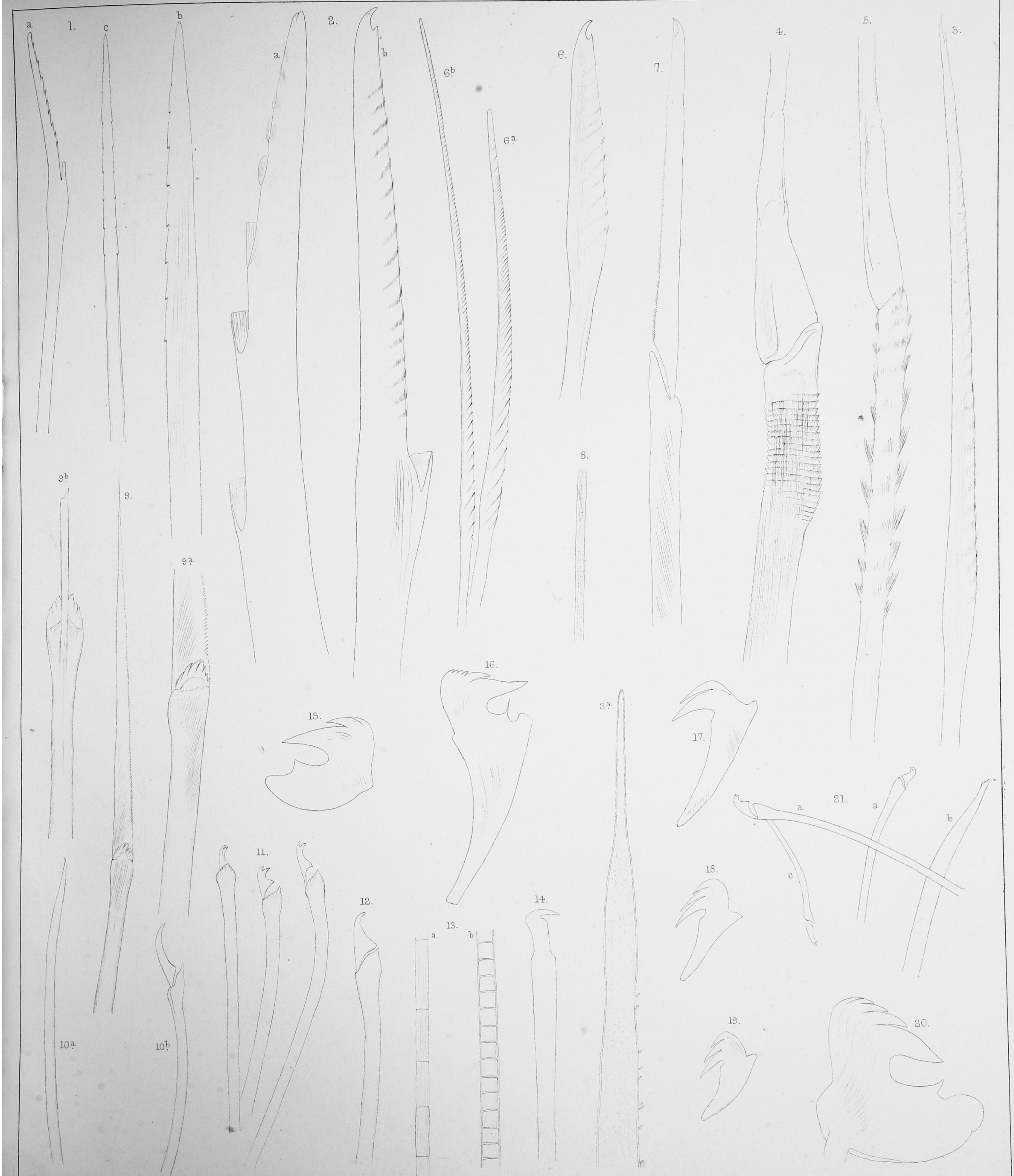

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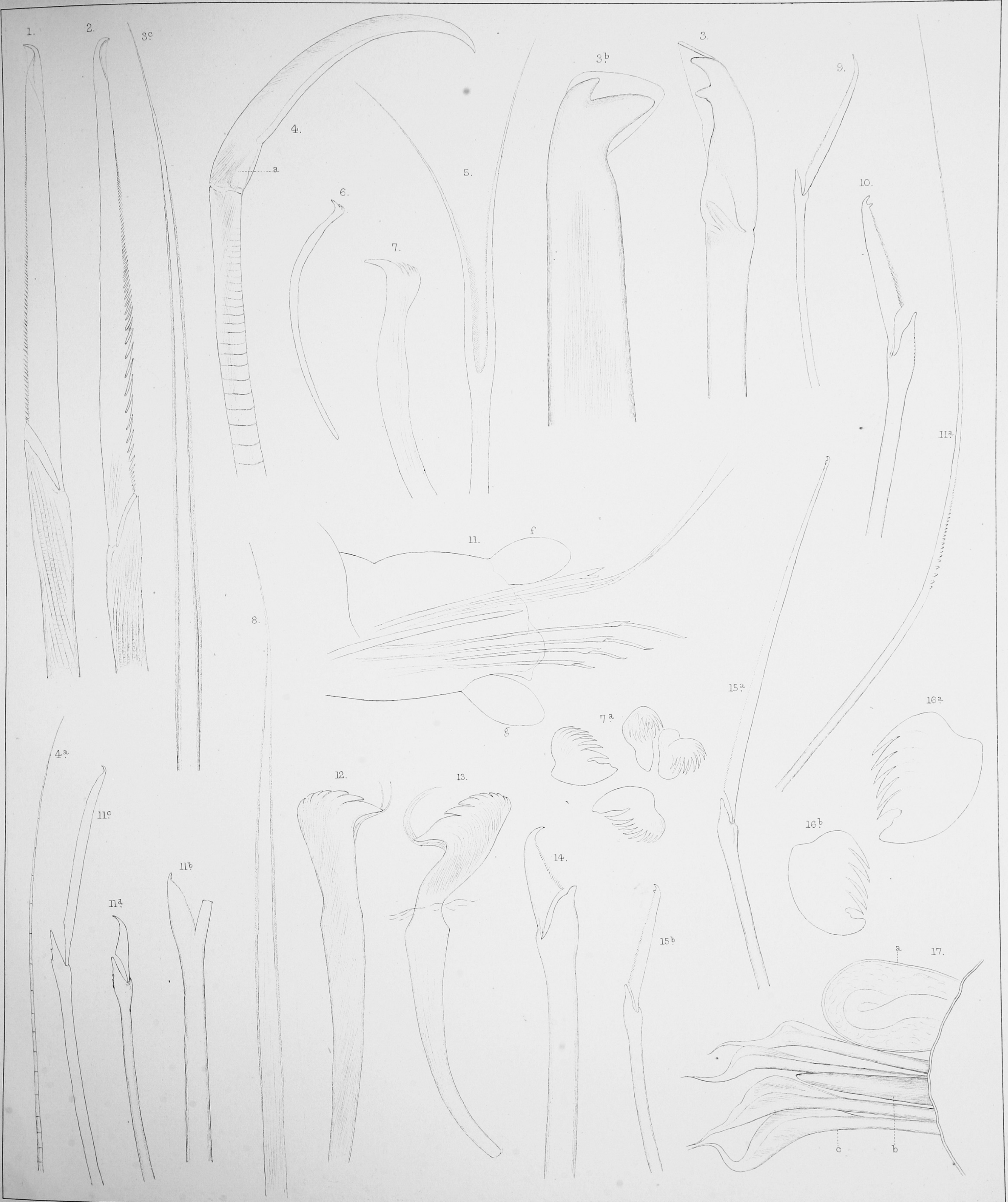

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