THE MICROSCOPE.

PUBLISHED ON THE 10TH OF EACH MONTH,

At 25 Washington Avenue, Detroit, Mich.

All articles for publication, books for review and exchanges should be addressed to the Editors of "THE MICROSCOPE," 25 Washington Ave., Detroit, Mich.

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VOL. VIII. DETROIT, FEBRUARY, 1888. No. 2

ORIGINAL COMMUNICATIONS.

NOTES ON TWO PRESUMABLY UNDESCRIBED AQUATIC WORMS.

DR. ALFRED C. STOKES.

PLATE II.

I.

THE aquatic worms of this country form a large group of animals demanding the use of the microscope for the elucidation of their structure; yet, although they are abundant and attractive, they have received but little attention. Those extremely interesting annelida which are classed together under the suborder Oligochæta have been studied by a still more limited number. Dr. Joseph Leidy has increased our knowledge of certain genera and species, and Dr. Gustaf Eisen has been a careful and successful investigator, describing several wonderful and previously unknown forms, notably the type of a new family group (Eclipidrilidæ), the worm having its habitat in the high Sierra Nevada of California, at an altitude of ten thousand feet or more. In reference to the detailed anatomy and histology of any Oligochæte, I am acquainted with but one paper, that on *Aulophorus vagus*, Leidy., published in the *Proceedings of the American Academy of Arts and Sciences* for October, 1884, by Mr. Jacob Reighard. Further than this little has been done. The field is, therefore, almost entirely uncultivated, and, presenting, as it does, an almost undisturbed surface, it awaits the coming of the scientific investigator, being ready to respond to his slightest touch, and to reward him most abundantly for a little patient attention.

To properly investigate these aquatic creatures, the microscopist should be able to successfully use the microtome. The worms are, as a rule, transparent, but the attempt to study the various parts and organs through the tegumentary coat of the living, writhing animal is somewhat difficult, and apt to be followed by errors of interpretation. The histology of the various parts can be satisfactorily investigated only by means of stained and serial sections, but microtome work over creatures whose bodies are visible to the naked eye chiefly by reason of their length and not on account of their size in other directions, is work for the expert. And here is an obstacle. It is not every microscopical student, working alone, who can possess the instrument needed for such delicate cutting, and he has consequently not acquired the skill necessary, not only for the manipulation of the microtome, but for the preliminary treatment of the specimens. This is the writer's unfortunate situation, although he has been so highly favored as to obtain the assistance of an expert microtomist, who will take one of the subjects of this paper, and prepare it for future study, the results of which will be embodied in another essay supplementary to the present one. The following description, therefore, of some points in the anatomy of two presumably undescribed aquatic worms is superficial, but it is the result of prolonged and repeated study of the living creatures.

II.

ÆOLOSOMA DISTICHUM, SP. NOV. (FIG. 1.)

For three years past the writer has been finding the worms here referred to, often in great profusion. They appear to favor the depth of stale or even partially decayed collections of aquatic plants left standing in the light and warmth of a room, occasionally presenting themselves in abundance in such places. I have no recollection of capturing any from an open pond or pool. They were first obtained among a decaying mass of *Sphagnum*, which had been gathered several months before and had remained in a covered vessel until the water was thickly coated with a slimy mass of microscopic fungi, on the surface of which the worms glided in great numbers, and where they seemed to find a plentiful supply of food. More recently they have developed in such quantities in an old infusion of dead autumn leaves that the small and almost filiform bodies became conspicuous by reason of their numbers. In a vessel containing decaying *Lemna*, *Myriophyllum* and other aquatic plants they have appeared suddenly and plentifully. In a similar mass of decaying vegetation originally brought from the cypress swamps of Southern Florida,

they have also become developed, and finally they have appeared in a small collection of *Lemna*, sent to the writer for another purpose by Mr. H. E. Valentine, of Boston, and left standing on the table for several weeks. They therefore seem to prefer the proximity of decaying vegetation, and their habitat appears to be in favorable situations along the entire Eastern coast, south of and including Massachusetts.

The food consists chiefly of the softened and decaying leaflets and other parts of the plants, together with the fine, granular debris which collects at the bottom of the water. These matters are seized by a snapping motion of the mouth and lower lip. Animal food appears to be taken by accident only; it consists chiefly of Rhizopods.

The only American species of *Æolosoma*, with the exception of the one here referred to, was discovered by Dr. Joseph Leidy, and was described by him in the *Journal of the Academy of Natural Sciences, of Philadelphia*, II, 2, November, 1850.* He named it *Æolosoma venustum*, having obtained it among Confervæ, upon which it feeds, in fresh water ditches near Philadelphia. Upon the present form I propose to bestow the specific name *distichum*.

Two characteristics of the genus *Æolosoma* are the absence of the podal spines, so common in certain Oligochæta, and the presence of numerous, scattered, bright red spots which, at first glance, appear to be superficial, but are, on the contrary, embedded within the tegument. In *Æ. venustum*, Dr. Leidy states that "the red globules variegating the posterior part of the body appear to be colored nuclei in the muscular bands of the tegument." The same appearance obtains with the entire body of *Æ. distichum*, where, in some instances, the transverse muscular bands become very distinct, and the red spots correspondingly conspicuous.

The body is colorless, depressed, broad, changeable in form, and attractively variegated by these large, irregular, red spots distinctive of the genus. The articulations vary in number from eight to twelve, all of which, except the first, or oral one, are furnished with apparently four fascicles of bristles, two on each side (one dorso-lateral and one ventro-lateral), but this arrangement is apparent only. The two fascicles on each setigerous segment, (one on each side) are divided into two somewhat widely separated parts, each articulation therefore, except the first, seeming to have four fascicles

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*Since this was written Prof. F. W. Cragin has described two additional forms from Kansas, naming them *Æ. Leidyi* and *Æ. Stokesii* respectively. (*Bul. Washburn College Laboratory*, II. 2, Oct. 1887.)

of setæ instead of the usual two. Each of the two parts of the compound cluster is composed of from four to eight simple bristles of unequal length, each entire compound fascicle being consequently formed of from eight to sixteen setæ, or of from two or four short bristles intercalated between two or four long setæ in each secondary cluster. The long setæ usually exceed in length the breadth of the extended body, while the shorter ones are about one-half that length, stouter, and gently curved at the distal extremities. None are furcate. Each of the two parts composing each compound fascicle has several (four or more) muscular threads which are independent of those of the other secondary cluster, but both are connected by a large and apparently strong muscle passing transversely from one secondary bristle-sac to the other. As a rule there are four long and four short setæ in each of the separated parts.

The oral segment is produced anteriorly as a large lip, which is subcircular in outline, and soft and changeable in form. Its entire lower surface is clothed with fine vibratile cilia. In *Æ. venustum*, Leidy states that the cilia fringe the edges of the hexagonal cells composing the under surface of the lip, but such an arrangement does not obtain with the present species, the whole surface of the part being evenly clothed with the fibrillæ.

The anal segment is somewhat narrower than the other articulations, obtusely rounded at the extremity, which is centrally emarginate. Its posterior border, as well as the anterior margin of the upper lip, is hispid with fine, short hairs. The general body surface bears many similar short, scattered setæ.

The mouth is surrounded laterally and posteriorly by a thick, muscular lip, shaped somewhat like the letter U, the arms extended forwards. It is strongly ciliated and opens into a short but capacious pharyngeal passage, which, at the second articulation, contracts and is continued as a narrow, often tortuous, œsophagus, which extends through the second segment to about the middle of the third, where it dilates into the digestive cavity proper. The latter is broadest centrally, and extends to near the sixth segment, when it gradually narrows and is continued posteriorly to the terminal anal aperture. The walls are thick, and the internal surface of the entire alimentary canal is ciliated, the cilia of the rectum being large and powerful, producing a strong current, and often rotating the excrementitious mass before it is expelled. They frequently project as a small cluster beyond the anal aperture. The cilia of the remaining surfaces are fine and short.

The tortuous segmental organs are a single pair in each segment except the oral, and perhaps the anal. They open externally by a minute pore near the centre of the ventral surface, and close to the median line of the body. The tubules are intimately adherent to each other, forming a flattened cluster, one margin of which is usually attached to the body wall, the rest of the organ floating freely within the body cavity. A long duct connects each with the side of the intestinal canal, and opens by an external orifice as already indicated. The tubules do not originate by a dilated, funnel-like orifice, but by a slightly expanded opening whose aperture, and the external walls for a short distance, are clothed with long, fine cilia (Fig. 2).

Mr. E. C. Bousfield (*Journal Linnæan Society of London*, xx, 1887) "regards the segmental organ as purely mechanical in function, 'in preventing undue distention of the body by the fluid which passes through the walls of the intestine, and is doubtless charged with effete material from the blood-vessels which run in contact with it.' Moreover, what is generally considered to be the movement of cilia in these organs he maintains to be due to the vibration of a membrane, the free edge of which can be seen when vitality is at a low ebb. Observations on *Tubifex*, *Nais*, *Stylaria*, and *Æolosoma* lead him to this view."* That the vibratory appearance within the tubules is due to an undulating membrane is not correct so far as the present species of *Æolosoma* is concerned. Not only are the internal walls ciliated, but the cilia project beyond and around the free extremity and, in some instances, extend for a short distance down the external surface.

The dorsal vessel, at its anterior portion contracts vigorously. Near the posterior region of the digestive enlargement of the alimentary canal it divides into several ramifications which extend over the surface of the part, and presumably reunite anteriorly to form the single vessel there conspicuously visible. At the posterior border of the pharynx the dorsal vessel gives off two lateral branches which extend around and below the pharyngeal passage, and unite to form the single ventral vessel, while the main trunk continues forward to beyond the mouth where it furcates into a right and left hand branch, each of which passes downward and backward to join the ventral portions of the pharyngeal vessels. This is at least my interpretation of the appearances. As the blood is so nearly colorless, and the dorsal vessel is clearly visible only during its expan-

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* *Jour. Royal Micros. Soc.*, October, 1887.

sion, the points at which the anterior branches enter the ventral part of the pharyngeal vessels may have been misinterpreted. The apparent arrangement is shown in the diagram (Fig. 3).

The fluid of the body cavity seldom contains those freely floating, granular corpuscles often so abundant within the body of other aquatic worms.

The nervous system can be studied satisfactorily only after sectioning and staining. This must, therefore, be postponed.

The worm's swimming movements are not performed by the lateral undulations of the body so common with *Pristina*, *Nais*, and other Oligochæta. The labial cilia are here the chief organs of natation, and by their aid the worm advances evenly and smoothly through the water.

Although very many individuals have been examined, none have been found sexually mature. The only form of reproduction observed is by transverse fission, which takes place rapidly, a single individual not rarely presenting evidences of two reproductive divisions.

In length the extended body may reach $\frac{4}{10}$ inch. The smallest forms observed measured only about $\frac{1}{24}$ inch in length.

III.

PRISTINA FLAVIFRONS, SP. NOV.

The body is for the most part colorless, or very pale brownish, depressed sub-cylindrical, the articulations, of which there are from thirty-seven to sixty-three, being quite uniform in width except near the two extremities. The posterior or anal segment is narrowed, tapering, and terminated by two rounded papillæ, one on each side of the anal aperture. These are hispid with short, stiff hairs (Fig. 4), as also is the entire body, but sparingly so, the short setæ being widely separated.

The upper lip terminating the anterior extremity is somewhat widened, and the pharyngeal segments immediately behind it are slightly constricted. The lip is itself formed of a conspicuous, rounded lobe on each side, with a deep depression separating them (Fig. 5), the long, soft and flexible proboscidiform process springing from this central concavity, the entire region being hispid with many short, stiff hairs. The lip measures from $\frac{1}{200}$ to $\frac{1}{120}$ inch in length from the mouth, and, when the worm is observed in profile, the part seems to be depressed, rounded inferiorly, and slightly curved upward so that it has, in longitudinal optic section, a concavo-convex

outline (Fig. 6). The proboscis-like organ varies in length from $\frac{1}{37}$ to $\frac{1}{24}$ inch from the distal extremity of the lip, its length seeming to depend upon the size of the worm that bears it. It is thick-walled and hollow, and communicates with the body cavity.

The two eyes are placed on the oral segment, one at each angle of the mouth, on the ventro-lateral border. The mouth is large, and, when expanded, is round, at other times showing itself as a transverse, irregularly slit-like fissure.

Every articulation, except the first, is supplied on the ventral surface with two fascicles of podal stylets, with from three to seven stylets in each cluster. In the posterior segments these appendages become successively smaller and more rudimentary, until the anal articulation usually has only a trace of a few short spines, or often none. There is no invariable rule as to the number of stylets in each fascicle, the cluster on one side often differing in number from the one on the opposite border of the same segment. Frequently there are only three; more than seven I have never seen in one fascicle. In form they are long sigmoid, terminating in a double unguis, one limb of the hook being very small and inconspicuous. The inner or attached end of the stylet is angularly bent and conically tapering, the rounded enlargement common to the podal spines of so many aquatic worms here usually being absent, or represented by a very inconspicuous swelling at the first angle. In length the stylets measure from $\frac{1}{182}$ to $\frac{1}{167}$ inch. One spine is shown much enlarged in Fig. 7.

Beginning at the sixth articulation, and continued to near the posterior extremity, the segments have on both sides a single dorso-lateral bristle, usually accompanied by one or more short, straight, rudimentary hairs, the former measuring from $\frac{1}{75}$ to $\frac{1}{50}$ inch in length, except on the extreme posterior articulations where they become mere rudiments. There are none on the oral or pharyngeal segments in front of the sixth body-ring. They frequently vary in length on opposite sides, the short bristles being, as I suppose, newly produced and in process of growth to supply the place of the fully developed setæ that have been lost. Indeed, they seem to leave the body with great facility, as they often fall away while the worm is under the microscope, and specimens are not rarely taken with the central part of the body entirely free of all appendages except the podal stylets. But beginning at about the twentieth segment from the posterior extremity, the bristles gradually and regularly decrease in length (Fig. 4), until the anal articulation is reached,

when they have become mere rudiments, $\frac{1}{400}$ inch or less in length, the articulations posterior to this point bearing rudimentary podal stylets only. This arrangement of the bristles gives the worm an attractive and unique appearance, when present in the beautiful regularity often to be observed. Occasionally, especially in the largest and presumably oldest worms, the symmetrical arrangement is interrupted by the interposition of one or more extremely long bristles.

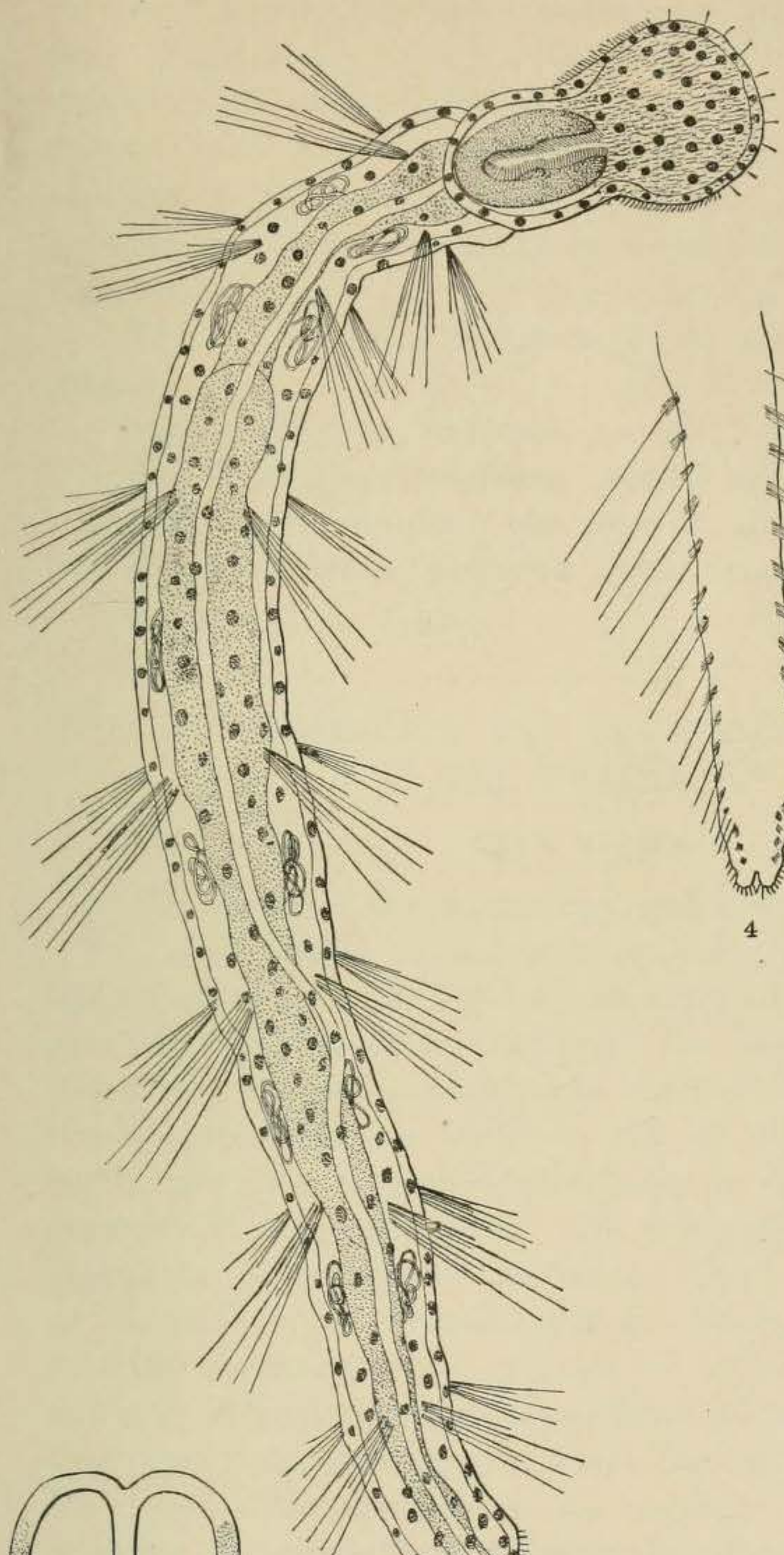
The intestinal canal is capacious, brown in color, moderately tortuous, and distinctly divided into pharynx, œsophagus and intestine. The pharynx extends from the mouth to the beginning of the sixth articulation. It is protrusible, the worm thrusting it out in order to seize the vegetable particles and diatoms on which it feeds, and at times using it as a sucker to assist in progression. The upper surface of the passage is ciliated, and one characteristic feature, the one that has suggested the specific name, is the lemon-yellow color which tinges the whole organ, and extends to the beginning of the œsophagus, where it abruptly ceases. It extends into the upper lip where it is most distinct near the lateral margins. In both these parts the color often deepens to an orange hue.

At the beginning of the sixth articulation the pharynx is contracted and becomes the œsophagus, which occupies only the sixth and seventh segments. In the eighth the passage suddenly dilates into a sub-cordiform or sub-spheroidal sac, the intestine again narrowing in the ninth, while in the tenth and eleventh it again forms an obovate enlargement, contracting near the beginning of the eleventh, and thence continuing tortuously to the anal aperture. The portion of the canal passing through the fifteen or sixteen posterior articulations is ciliated.

From the beginning of the œsophagus at the sixth segment to within five or six articulations of the posterior extremity, often as far as the anal segment, the tubular passage is abundantly supplied with small, golden-brown granules or refractive oil drops, probably representing an hepatic organ, or being cells having an hepatic function. They are densely aggregated over the intestine near each membranous dissepiment, the tube appearing to be transversely striated by very dark, narrow bands.

Segmental organs, apparently ciliated, are present on each side of most of the articulations.

The worm measures from $\frac{3}{10}$ to $\frac{4}{10}$ inch in length; in greatest width $\frac{1}{100}$ inch. It has been obtained in abundance on the lower



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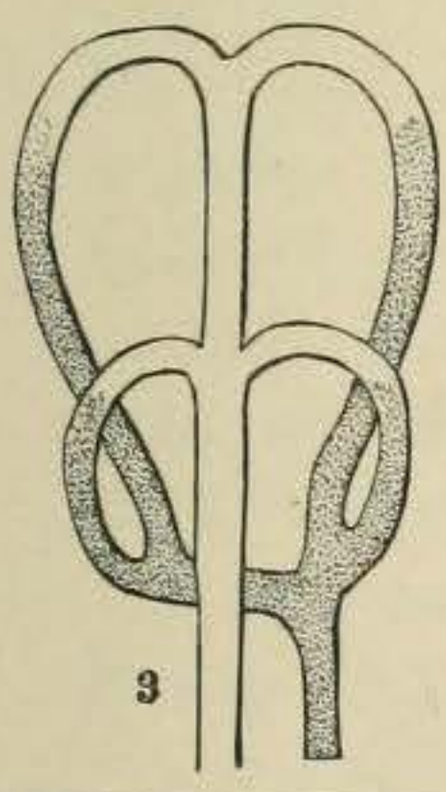

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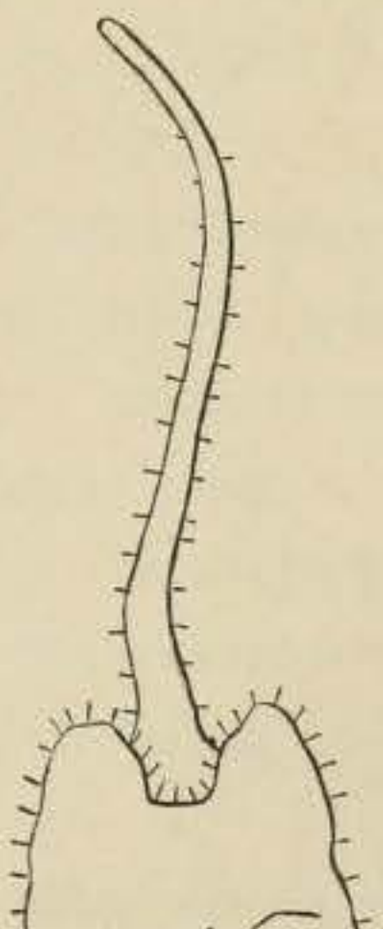

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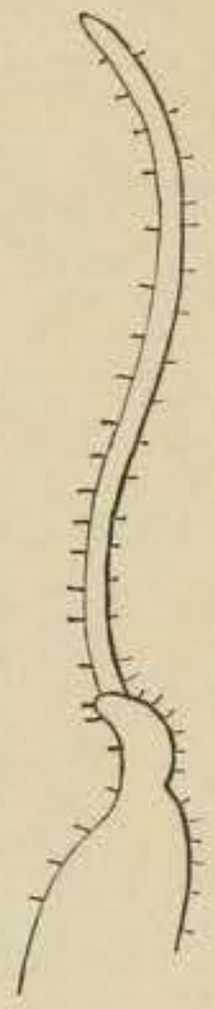

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PLATE II.

surface of *Lemna polyrrhiza*, and among the leaflets of *Myriophyllum*. None have been found sexually mature, reproduction being ordinarily by transverse fission.

EXPLANATION OF THE PLATE.

Fig. 1. *Æolosoma distichum, sp. nov.*

Fig. 2. *Æolosoma distichum*, termination of segmental organ; diagram.

Fig. 3. *Æolosoma distichum*, blood vessels of the head; diagram.

Fig. 4. *Pristina flavifrons*, posterior extremity.

Fig. 5. *Pristina flavifrons*, anterior extremity; ventral view.

Fig. 6. *Pristina flavifrons*, anterior extremity; profile.

Fig. 7. *Pristina flavifrons*, podal stylet.

TRENTON, NEW JERSEY.

THE SPECTROSCOPE AND ITS APPLICATION TO MEDICAL PRACTICE.*

DR. S. WATERMAN.

THE telescope, the microscope, and the spectroscope are three great lights to aid man in scientific investigations. The telescope has conquered space, and revealed to us the beauty and grandeur of the starry heavens; the microscope has made us acquainted with a new world, with a miniature creation, invisible to our unaided vision, a world so full of beauties and enchanting sights, and of the greatest usefulness to unravel the structure of organic and inorganic matter. The spectroscope, with its analytical prisms, has revealed to us the composition of celestial worlds, as well as the chemistry of terrestial matter. We may leave the astronomer to sweep the infinite realm of space for new wonders and new discoveries; enthusiastic votaries penetrate the infinitesimal world with their powerful microscopes, in which department it reigns supreme. To describe the spectroscope, its wonderful analytical powers, its conquest in celestial and terrestial chemistry, this, it shall be my task to lay before your kind consideration; in rendering an account of the spectroscope, and its applicability to medicine, we enter a field of inquiry, whose limits have not yet been reached, nor its depth and breadth fully explored.

It is not claimed that the spectral, or prismatic test is destined to supersede other modes of procedures hitherto employed by the