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THE NATURAL HISTORY OF THE HAIRY-BACKED ANIMALCULES (CHÆTONOTIDÆ).

BY PHILIP HENRY GOSSE, F.R.S.

(With Two Plates.)

WHOEVER has been in the habit of collecting the floccose matter that accumulates around the submerged stems of aquatic plants, or the impalpable sediment that lies at the bottom of still pools and running ditches, and of examining the same in the live-boxes of his microscope, is aware how abundant and how various are the forms of life that are presented to his view. Creatures the most strange and the most incongruous—odd in their shapes, odd in their structure, odd in their manners, odd in their movements, swim, or rotate, or creep, or wriggle over the field of vision, till the little pellet of brown mud, no bigger than a grain of duck-shot, flattened out before him, proves a complete microcosm. Many such pellets will not have passed under the eye of the curious observer before he will pretty certainly have become familiar with a little creature of attractive appearance and lively manners, which forms the typical representative of a limited group of animals, whose family name I have set at the head of this article. Dr. Ehrenberg, of Berlin, named it the Bristle-fish (*Chaetonotus*), both of which appellations allude to the long and stout bristles with which its back is beset in rows. Its movements are not so rapid as those of many animalcules, and therefore it affords a fair object for the young microscopist, while its form is so peculiar as to be easily recognized. When enclosed in an aquatic live-box, it is fond of crawling on the surface of the glass cover, whereby we distinctly see the ventral surface, as we see the lateral form when it creeps about the stems. The form, when seen vertically, is somewhat fish-like, with a thick, blunt, and rather triangular head, and a slight constriction or neck; a swelling body, terminating in two diverging points. The figure, when

seen sidewise, reminds one of that of a ferret, the back being much arched (Plate i. Fig. 1). The whole body appears covered with hairs, which are set in rows; those on the front part are smaller and closer, those on the back larger and fewer. The fore-part, seen from beneath, presents an appearance of hatching or cross lines running diagonally, or else of dots set in quincunx, which I suppose are the bases of the hairs growing in such an arrangement. The internal structure is not usually discernible; for though the body is pellucid and colourless, and often lustrous from the refraction of the light, especially through the neck, the number of hairs which stud the surface prevent a clear sight of the interior. Two bands, which run down the belly, are understood to be bands of cilia. There is a certain nimbleness and sprightliness in the motions of this pretty animal as it crawls, frequently turning short on itself and changing its course (see Fig. 2), examining various objects, much like a caterpillar does, with apparent intelligence. I shall return to this species again for fuller details; but this general description will help the reader better to understand the group of which I propose to treat.

The form appears to have been recognized in the earliest records of microscopic observation; for Joblot, nearly a century and a half ago, described an animalcule, which was probably enough this very creature, under the title of "Poisson à tête tréflée." I say "probably," because an *approximation* to the general outline of such minute creatures was all that, with their very imperfect instruments, the early observers could accomplish. About sixty years later Müller, the great Danish zoologist, and the first who attempted to define and arrange the host of microscopic animalcules that were crowding upon observers, described under two names—*Cercaria podura* and *Trichoda larus*—what may have been two species of the same family, or one. The two specific names have, however, been adopted in modern nomenclature, as representing two distinct creatures, the latter being appropriated to the one I have described; though on what account he applied the name *larus*, which signifies a gull, to it, I cannot conjecture. Passing by other observers, who have recorded nothing more worthy of note concerning the form, than that they recognized it, we come to Ehrenberg, who, in his valuable papers in the Transactions of the Berlin Academy for 1831, and afterwards in his notable work *Die Infusionsthierehen*, determined the two genera, *Ichthyidium* and *Chaetonotus*, for the two species described by Müller, adopting his specific names, and added two more species to the latter genus.

The great Prussian zoologist included these creatures among the ROTIFERA, uniting with them in the same group two other

genera, which have no real affinity with them, his system of arrangement being artificial, and therefore, necessarily, in some cases, unnatural.*

M. Dujardin, in 1841, described another species, which he named *Ch. squammatus*, and rejecting Ehrenberg's arrangement, united the then known forms with others, with which they have no more affinity, and placed the heterogeneous group among the Infusory animalcules by the name of *Symmetrical Infusoria*. His ground for the change is thus expressed:—"The Ichthyidina, according to M. Ehrenberg, ought to have a rotatory organ, simple, continuous, with an entire margin; but, in fact, the vibratile cilia of the ventral surface of the Chaetonotes do not at all constitute a rotatory organ."†

Ten years later, the same zoologist described another form (Plate ii. Fig. 16) under the title of *Echinodera*,‡ apparently allied to the same group; to which, however, he now assigned a higher place, viz., intermediate between Crustacea and Vermes. He believes that this is "a type differing from the *Helminthes acanthocéphales*, the *Systolides* [Rotifera], the *Entomostraca Copepoda* [Cyclops, etc.] and the Sipuncies, yet at the same time offering points of resemblance to each of these. It is a sort of *Copepode* without feet, with the mouth of a *Sipunculus*, and the neck of an *Echinorhynchus*, and a muscular cesophagus like those of the *Systolides*, the *Tardigrades*, and the *Nematoid Helminthes*."

M. Perty§ and Herr Vogt|| concur in the exclusion of the *Chaetonotidae* from the ROTIFERA; the former, however, has not ventured to assign them any definite position, while the latter associates them with the Planarioid worms (TURBELLARIA).

* It is the fashion to depreciate and decry Ehrenberg. I have no sympathy with those who, taking their stand upon the ground which he has cleared with incredible labour and genius, can assume airs of pity or contempt when they discern inconsistencies or defects in his system. Many years' study of the Rotifera has enabled me in some measure to appreciate the gigantic labours of the Prussian microscopist, and to compare them with those of his successors and critics. I take, for example, Dujardin's *Hist. des Infusoires*, and have no hesitation in asserting that this work does not manifest one-fourth part of the real actual acquaintance with the subjects treated, that is possessed by Ehrenberg's great work. Corrections and improvements in some points cannot fail to be pointed out by those who begin where the Prussian left off; and the advance of science, and the improvement of the microscope itself, have, of course, made antiquated and displaced many of his statements and conclusions; but, looking at microscopic zoology as it was when Ehrenberg took it up, and as it was when he laid it down, I think it not too much to say that he stands in the foremost ranks of the scientific army, side by side with such names as Aristotle, Linnaeus, and Cuvier, and that his *Die Infusionsthierehen* is a monument to his fame, *vere perennius*, and such as few indeed have been able to erect.

† *Hist. des Infus.*, p. 569.

‡ *Annal. d. Sci. Nat.* 1851. The name is erroneously spelled "Ellimoderia" in the 4th Ed. of Pritchard's *Infusoria*, p. 380.

§ *Zur Kenntniss kleinster Lebensformen*.

|| *Zoologische Briefe*.

Dr. Max Schulze, describing yet another genus, *Turbanella* (Pl. ii. Fig. 15), in 1853,* took occasion to institute an elaborate examination of the structure of the whole group, augmented by all these discoveries. He considers that it does without doubt fall within the great circle of VERMES, though there is some difficulty in determining in which class to place it. Its union with the ROTIFERA he judges impossible: 1, because of the absence of the vibratory organs around the mouth, so characteristic of that class; 2, because muscles, nerves, and water-vessels—organs which are wanting in no true Rotifera—have not been found in this group; 3, because of the absence of a caudal extremity, furnished with articulated members; and 4, because of the peculiar cilia with which the ventral surface is clothed in the Chaetonotes. *Turbanella* shows traces of a division into segments in the separation of the head from the rest of the body, in the ring of cilia which surrounds the head, and in the position of the almost regularly recurring lateral processes, and thus reminds us, in its ciliation and its obscure articulation, of several states of development of the true ANNELIDA. I may add, that the *Echinodera* of Dujardin, and my own curious genus, *Taphrocampa* (Figs. 17—19), presently to be described, carry this appearance of segmentation still further, and, *pro tanto*, strengthen the grounds of affinity with the ANNELIDA.

Dr. Schulze cites the analogy of certain Annelida, which possess, even in the adult condition, a ciliated skin. *Polyophthalmus* (Quatref.) has a ciliary head-veil, not unlike that of the Rotifera. The genus *Spio* is provided, according to Oersted (confirmed by Schulze's own observations), with ciliated gill-leaves; its two long frontal cirri are also ciliated, and so are the pair of longer appendages, which, seated on the second segment, project at right angles from the body, as noticed in a species found at Cuxhaven.

The claim of the TURBELLARIA to afford a refuge for these strangers, which, like homeless paupers passed from parish to parish, are found so difficult to settle, is next brought under review. All the Vortex-worms have a ciliated covering, spread entirely and uniformly over the body; their skin is soft and melting; their digestive canal is destitute of a firm envelope, and is separated from the soft parenchyme of the body only by its wall, formed of peculiar digestive cells, or hepatic cells. Muscle-threads, the central portion of a nervous system, and water-vessels, are recognized in all these worms.† In *Chæ-*

* *Archiv f. Anat. Physiol.*, etc, 1853, p. 241, et seq.

† "In *Microstomum lineare*, in which neither Oskar Schmidt nor I could formerly discover any trace of a water-vascular system, I have lately recognized such, furnished with very small tremulous tags, and also distinct muscle-threads."—*N. L. Z. D. Schulze*

tonotus and *Turbanella* the skin is not melting, but capable of resisting, to some extent, cold potass solution. It is ciliated only on the ventral surface, and, in the former genus, only on a portion even of this. The ring of cilia which surrounds the head of *Turbanella*, and the muscular coat of the alimentary canal of the Chaetonotes generally, sharply defined against the parenchyme of the body, especially in the anterior third, are conditions unknown among the *Turbellaria*; while the motory muscles, nerve-threads, and water-vessels common to them, have not been recognized in those. Yet Dr. Schulze judges that a certain relationship between the *Chaetonotidæ* and the TURBELLARIA is not to be mistaken: 1, because of their inarticulate body, in size and form resembling the little Vortex-worms; 2, because of the absence of any other locomotive organs than skin-cilia, by means of which, though covering only one half of the body, the animals yet proceed with a soft gliding motion, like that of the Vortex-worms; 3, because the absence of muscles, nerves, and vessels is approached by the obscure condition and receding development of these organs in many of the more minute *Rhabdocæla* and *Microstomata*. Thus there seems here a closer affinity than with the ANNELIDA.

Difficulties, however, beset the attempt to assign to the *Chaetonotidæ* their natural place in the class TURBELLARIA. The *Dendrocæla* and the *Rhyncocæla* are at once excluded; the former consisting of animals of superior size, furnished with a ramified intestine without an anal orifice; the latter having, indeed, a straight intestine, provided with an anus, but invariably possessing a protrusile proboscis. There remain the *Rhabdocæla* and the *Arhynchia*.* Both these groups contain small forms, resembling those of the *Chaetonotidæ*; but the former have an intestine without an anus, and a hermaphrodite system of reproduction; the latter an anal orifice, but a dioecious reproduction. Thus the *Chaetonotidæ*, hermaphrodite and furnished with an anus, cannot, without force, be referred to either.

In the TURBELLARIA, as in the VERMES generally, those characters which are drawn from the form of the alimentary canal have a higher systematic signification than such as depend on the condition of the reproductive system. If the *Chaetonotidæ*, then, are to be placed among the TURBELLARIA, Dr. Schulze would associate them, not with the *Rhabdocæla*, but with the *Arhynchia*; which would include the *Microstomata* and *Dinophilus* as dioecious, the *Chaetonotidæ* as monœcious forms.

Finally, this able zoologist, taking into consideration all the facts recorded, considers it premature to determine the actual

* Vide Schulze's *Beitr. z. Naturg. d. Turbellarien*.

relation of the family in question. Assigning to them a provisional place among the TURBELLARIA, as just indicated, he admits that further investigations of the anatomy of this little examined group may bring to light relations hardly suspected; while many forms more or less closely allied may still lurk undiscovered, acquaintance with which may modify our already accepted conclusions. Dujardin's curious little *Echinodera*, and my own equally anomalous *Taphrocampa*, appear, for example, to widen the distance between the group and the TURBELLARIA; while, in their more strongly marked segmentation they show a decided approach to the Annelidous forms.

Having thus given to the reader an abstract of the views of one of the most learned of Continental zoologists on this obscure group, I proceed to describe all the species as yet recognized in it, premising that I have myself met with some, manifestly belonging to before-unknown genera, and other species which seem irreconcilable with published descriptions and figures of such as had been recognized. These I propose to include.

FAMILY CHÆTONOTIDÆ.

I think it desirable that the family should be named after the most characteristic and most populous genus, which is indubitably *Chætonotus*, and not *Ichthyidium*. It consists of soft-bodied animals microscopically minute, of lengthened form, having a bilateral symmetry, with a more or less distinct separation of the head; the body more or less clothed with vibratory cilia, and for the most part with long hairs; the alimentary canal straight, and furnished with an orifice at each extremity. Inhabitants of fresh-water.

Genus I.—*ICHTHYIDIUM* (Ehrenberg).

Posterior extremity forked; body unfurnished with hair.

Sp. 1. *I. podura* (Müll.) This form has been often seen by the early observers, if we can be quite sure that it has not been confounded with *Chæt. larus*. Ehrenberg first certainly defined it, having met with it in Nubia, among conferva from the Nile, and subsequently near Berlin. The body is linear-oblong, with the anterior extremity swollen; sometimes three-lobed; often slightly constricted; the hind fork short. The ventral surface is flat, the dorsal arched, and destitute of hair. The largest specimens have not the least vestige of hair on the back. The animal is colourless or whitish, but sometimes tinged with yellow, through the distension of the wide intestine. A longitudinal band of cilia was in one specimen clearly seen by Ehrenberg, along the belly, but in other individuals,

though of large size, he could not with the utmost care discern it directly, though he saw a distinct rotation at the mouth. It swims more rarely than it crawls. Our specimen showed, in the hinder part of the thick body, a large dark egg, well developed.

This species appears to be rare; I have not myself met with it, nor have I noticed any record of its occurrence since the publication of Ehrenberg's observations.

Genus II.—*CHÆTONOTUS* (Ehr.).

Posterior extremity forked; body clothed with hair.

Sp. 2. *C. larus* (Müll.) (Pl. i. Figs. 1—3.) This is the most commonly observed species of the whole family, being very frequently met with among duckweed, conferva, and other aquatic vegetation. It is of moderate dimensions, as compared with others, ranging from 1-400th to 1-200th of an inch in length. Its body is not quite four times as long as broad; the head is roundish or obscurely triangular, passing insensibly into the thick neck which separates it from the swelling abdomen. The posterior extremity is deeply forked, the two divergent toes tapering to points, which are sometimes obtuse. Ehrenberg distinguishes the species by its having the hairs on the hinder portion of the back longer than those on the fore part; and in this distinction I concur with him, the specimens that I have seen possessing the character strongly marked, sometimes excessively. These long hairs are few, and spring out of a dense coat of short hair, which clothes the whole body, but most thickly behind. Probably this is what M. Dujardin refers to when he remarks that "looking at it in profile we recognize that the back is covered with asperities from between which the long straight hairs spring."* No one that I am aware of has remarked a curious circumstance, that the sides of the head are furnished (Fig. 3) with some very long slender hairs, which stand out laterally, diverging, curving slightly forward, like the whiskers of a cat. I have observed the animal frequently bend and straighten them rapidly, near the tips, one independently of another, with a movement very different from an ordinary ciliary vibration. A strong ciliary current is produced on each side, by which floating atoms are drawn towards the head, and then rapidly hurled about half-way down the body. Vigorous ciliary currents are seen to pass along the inferior surface of the neck: I have not often been able to define these as forming two bands, though occasionally they are traceable, reaching nearly as far as the bottom of the posterior cleft, and then turning abruptly up and run-

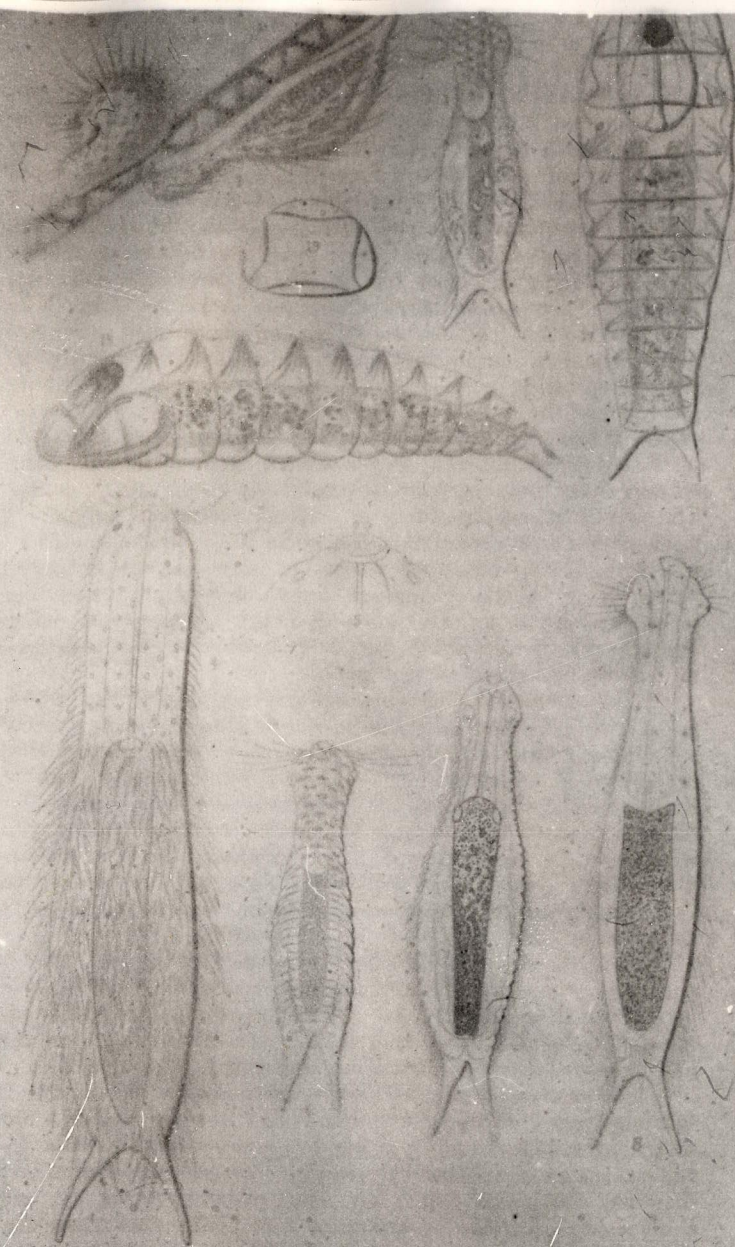
* *Hist. d. Infusoires*, p. 570. See, however, *infra*, under *Das. antenniger*.

ning forward along the sides. The mouth appears to me oval, minute, slightly protrusile; Ehrenberg describes it as a tube furnished with eight teeth. It leads into a gullet with very thick transparent walls, and a very slender perforation, which, at about one-third the total length of the animal, enters a straight intestine, of equal diameter with the gullet-wall. This, as I have seen it, has been generally colourless, loosely filled with irregular clear masses, and apparently terminating at a curved transverse line, considerably above the fork. This line is doubtless the outline of the swollen arched back, and marks the position of the cloaca, which, as is frequently the case, is visible only at the instant of its function. Ehrenberg has induced the digestive organs to receive indigo. The same observer has frequently seen a large developed egg contained in the ovary, which occupies the arched cavity of the abdomen, situate over (that is, more towards the back) the intestine. The egg is about one-third as long as the whole animal. I have seen the reproductive system in an inactive condition, merely as clear, refracting viscera of large size, and irregular shape, lying in the abdominal cavity, occasionally extending forward to the neck. On one occasion I am pretty sure that I saw, for a portion of its length, a tortuous water-vessel, running down one side. (See Fig. 3.)

The movements of this little animal are smooth and graceful, a sort of gliding or creeping over the water-plants; rarely swimming. Once I saw a *Paramecium* come blundering up against an unsuspecting *Chaetonotus*, who instantly doubled his pace as if frightened, but soon recovered his equanimity. Mr. Slack says, that among threads of conferva or decayed vegetation, he has observed it grope about, and shake them like a dog. (See *Marvels of Pond Life*, p. 84; where are two excellent figures of the species, and some interesting notes of its manners.)

Sp. 3. *C. maximus* (Ehr.) (Pl. i. Figs. 4 and 5). This is about twice the size of the preceding, measuring from 1-120th to 1-200th of an inch. The body is lengthened, slightly constricted, with the head turgid and obtusely triangular; the hairs on the upper surface short and equal. Such is Ehrenberg's definition of the species, who adds that the mouth is furnished with about eight feeble teeth (possibly papillæ). The distribution of the bristles in one he observed in distinct longitudinal rows; in another the arrangement appeared irregularly diagonal. A single egg is developed at once, greatly dilating the dorsal region of the abdomen, which Ehrenberg saw discharged by the cloaca above the foot-fork; he saw the germ-vesicle distinctly.

Dr. Schulze suggests the possibility that this species and



A. H. Gosse, del. &c.

HAIRY-BACKED ANIMALCULES.
Chaetonotidae.

1. *Chaetonotus larva*, crawling on a thread of conferva. 2. *C. maximus*, in the act of turning. 3. *C. maximus*, viewed from above. 4. *C. maximus*, with a large egg.

C. larus may be identical; but surely without good reason. He has added a good deal to our knowledge of its minuter anatomy; in particular he does not find the bristles of equal length, but longest on the back and hind end; and states that each is a pointed spine furnished with two minute subordinate spines, one springing on each side of its base. These spines are processes of the skin, not hairs inserted into it; but they are dissolved by potass more readily than the skin itself. The belly surface is quite destitute of spines, but it is uniformly clothed on the anterior half with short cilia, which on the posterior half are ranged in two bands along the edge, uniting above the fork. The median line of the belly is clothed with a row of short stiff down lying backwards.

The mouth, surrounded by eight or ten long, soft, and immoveable slender hairs, is formed by a circular membrane, either finely plaited, or beset with minute prominences ("teeth" Ehr.), protrusile, in the form of a short tube. Schulze recognizes the great egg with its germ-vesicle, and adds that it is covered with a shell, which potass does not dissolve. He also finds in front of the ovary a cellular spermatic gland, and two groups of spermatozoa; but fails to detect any trace of nerves, muscles, water-vessels, or tremulous tags.

In August, 1851, I found in a dyke near Stratford a very large *Chaetonotus*, which I am disposed to refer to this species. Its length was 1-70th of an inch, its greatest width 1-400th (but including the bristles 1-300th); length of the toes 1-580th. The dimensions, equal to those of a full-grown *Notommata aurita*, rendered it distinctly visible to the naked eye, and marked it from all others known to me. It was equally marked by its dense coat of rigid, spinous bristles, set all over the body on the upper surface and sides, and which are longer towards the hinder parts. The toes are small, slender, slightly knobbed and incurved; they can be made to approach, and even to cross each other. On the anterior half of the body the bases of the bristles are evidently set in quincunx in about eight rows visible; the spots are very distinct and strong. On the posterior half, the increased length and decumbency of the bristles cause a brown opacity and roughness; through which, however, the cylindrical intestine can be seen by focussing. The head is but slightly lobed, and the neck scarcely at all constricted. The mouth consists of a short tube, evidently protrusile, with a dark oval speck at the bottom in the centre, where a straight slender tube originates, and passes through a wide cylindrical cesophagus to the intestine, the head of the latter embracing its fundus. On the front and at each side of the head are very delicate curved hairs like vibrissæ. Just below the lower edge of the mouth are placed two minute hooked organs, the

end of which seem thickened and are bent downwards. Oval clear specks, one on each side of the face, may be eyes. (See Fig. 5.)

The manners were much like those of the rest of the genus. It was restless, crawling impatiently among the little masses of sediment, frequently turning itself double, and sometimes coiling almost into a circle; perpetually shortening and lengthening the head, protruding the mouth, and searching with the fore part, like a caterpillar. It sometimes swam briskly.

A much smaller individual, from the same dyke, had the bristles much fewer; they were, however, very coarse, and rigid and curved. A row of fine close-set vibrating cilia run along the side besides the bristles. I think it was a young one of the same species.

In a specimen recently dead, and lying on its side, I saw the lateral form of the mouth, and the traces of tooth-like striæ that surround it. I saw no bristles along the belly line, but they covered the whole sides. Certain irregular lines may possibly have been folds of the skin. The intestine was decurved, and terminated considerably short of the fork; it appeared to have a distinct portion at its anterior end, separated by a diaphragm. The toes were decurved. *I did not notice* the peculiar structure of the bristles observed by Schulze, but cannot affirm that it was not present.

Sp. 4. *C. brevis* (Ehr.). This is characterized by its minute dimensions, being only 1-430th of an inch in length, and by its having several eggs developed simultaneously, which are proportionally smaller. A doubtful species, and one which has not, I believe, been recognized by any other observer.

Sp. 5. *C. squammatus* (Duj.) (Pl. i. Fig. 6.) The hairs enlarged in the manner of scales, regularly imbricated, distinguish this species. M. Dujardin found it in January 1840, in a bottle of fresh water which he had kept for more than a year, having brought it originally from Paris to Toulouse.* On the upper surface it appears clothed with scales ranged in seven longitudinal rows, but on a side view these are seen to be the bases of short hairs which cover all the back, and even the forked foot. The mouth appeared surrounded by four or five papillæ, only occasionally visible. The vibratory cilia of the ventral surface are very long, especially on the anterior portion.

In 1850 I found what I presume to be this species, in a tub of water exposed in my garden for the propagation of Rotifera. A description, made at the time, without any knowledge of Dujardin's observations, I subjoin. Length 1-170th of an

* Pritchard (*Infus.* 4th Ed. p. 662) by mistake says "sea water from Toulouse."

inch. In form this resembles *C. larus*, being rather broad in proportion to the length. At first sight the body seems quite smooth, but on bending strongly to either side, it is seen to be clothed with hair, as it were agglutinated in locks, like human hair wetted; for these locks then separate. The outline of the head is slightly five-lobed, and on each side of the face there are several long slender bristles diverging laterally, like the whiskers of a cat. Along the ventral surface run two rows of vibratile cilia, extending the whole length; they appear to be longest near the front. I distinctly saw them in vibration throughout, and the motion communicated by them to the floating atoms was strong and conspicuous; these, however, were hurled backwards longitudinally only, with no trace of vortices.

The mouth, cesophagus, and alimentary canal do not differ from those of the next species; but the surface of the body presents something peculiar; it appears to be thrown into a number of transverse or annular wrinkles, possibly produced by the arrangement of the hair in locks. On the front third a number of transversely oblong dark spots are seen, arranged quincuncially with much regularity; their nature I could not determine, unless they also be divisions of the matted masses of hair; they are certainly not spots of positive colour. The whole animal is colourless; the intestine was granular, but appeared empty; it would not imbibe carmine. No reproductive organs were discernible. The forked toes are blunt at the tips; they are sometimes widely separated; that they are soft was manifest when one was bent by pressure against the glass, as the animal turned. It possesses the power of contraction and elongation to a slight extent; in the former the transverse wrinkles become more distinct, and the animal becomes shorter and broader. My specimen was very active, crawling nimbly, and swimming with much swiftness, but in an unsettled wandering manner. The body is very flexible, frequently turning so short as to be bent double.

Sp. 6. *C. Slackiæ* (Gosse). (Plate i. Fig. 7.) This undescribed species I venture to dedicate to a lady, to whose facile and elegant pencil microscopists are so much indebted for the beautiful and truthful delineations of *The Marvels of Pond Life*. I obtained it in January, 1851, from the sediment of the garden-tub already alluded to. Its length was 1-135th of an inch; its greatest breadth 1-600th. The proportions are nearly those of *C. larus*, but the outline of the head is the half of a short ellipse, without lobes, and it passes, with an abrupt angle, into the neck, which is somewhat more slender in proportion to the body than in the species just named. This form of the head gives a peculiar aspect to the physiognomy, and is the first appearance of a

character which is more marked in the following species, and more strongly still in the genus *Dasydytes*. The upper surface of the body is conspicuously studded with quincuncial dots, the optical effect of what I judge to be tubercles or warts so arranged, from which, perhaps, the hairs spring. (In the engraving I have not indicated this reticulation, that I might display more clearly some important particulars of the internal anatomy.) The back and sides are clothed with very fine hair of only moderate length, which is directed backwards. I did not detect any trace of facial vibrissæ.

The mouth is rather larger than usual, abruptly narrowed behind. The œsophagus is of the normal form, a cylinder with very thick transparent walls, centrally pierced by a slender tube. I was surprised to observe that the œsophagus did not embrace the mouth, but appeared to commence just behind it, by a peculiarity of structure not easy to explain (perhaps a sudden dip or angle carrying it out of focus, though in incessant manipulation, such a circumstance could scarcely have been undetected), apparently with a depressed centre, where the medial perforation began. (See Fig. 7.) Imbedded in the exterior wall of this viscus, on each side of its summit, was a minute oval dot, well defined, which at times appeared to have positive colour, and which reminded me of the eye-specks of Rotifera. At the posterior extremity of this perforated viscus (which in ignorance we call the *œsophagus*), about one-fourth of its length, having a vaulted figure, seemed separated by a delicate bounding line from the rest. The posterior extremity was slightly excavated, and seated upon the correspondingly convex summit of the intestine,—another deviation from the normal condition, in which the intestine embraces the œsophagus in a hollow. On each side of the summit of the intestine an oval clear vesicle was seated, having the appearance, situation, and doubtless function, of those glands which, in almost all Rotifera, we assume to be pancreatic.

But the most interesting result of examination was the indubitable discovery of a water-system on the plan of that of the Rotifera. Serpentine vessels ran along each side of the body-cavity (two visible on one side, one only on the other), which could be traced very distinctly (especially when the animal bent itself laterally) nearly to the fork, and in front to the occiput, where each ended in a clavate bulb. Immediately in front of this pair of bulbs, but not having any visible connection with them, were two globular vesicles, which refracted the light strongly, and were probably filled with some fluid. These were not distinct in the same focus that defined the minute eye-like specks, and hence must have been in the opposite (ventral) region of the head-cavity. After a while, one only of

these could be found, the other having vanished. Are they, then, contractile vesicles? The other viscera presented nothing remarkable.

Sp. 7. *C. gracilis* (Gosse). (Pl. i. Fig. 8.) This elegant species, which I obtained from a pond near Leamington, in July, 1850, is remarkable for the slenderness of its form, which is not broader than that of *C. larus*, while it is about twice its length. The head is dilated at the occiput, where it is abruptly joined to the narrow neck, somewhat triangular, divided into five well-marked rounded lobes, and fringed on each side with laterally-diverging straight hairs. In the middle of the frontal lobe is pierced the mouth, which is of the same form as in *C. Slackiæ*, with slightly protrusile lips. The œsophagus is of the ordinary form, but its anterior extremity is conterminous with the front of the head, with no such structure, and no such accessories as are seen in the species just named. Its length is unusual, for it extends nearly to the middle of the body, where, just before it enters the intestine, the thick muscular wall suddenly narrows, till it seems commensurate with the tube itself. The intestine is concave at its commencement, or rather, perhaps, it is furnished with a pancreatic gland on each side, which, as is frequently the case in the Rotifera, is pointed and ear-like. This suggestion, however, rests merely on the form; for I have not detected any bounding line between the points and the intestine, nor was their substance clear, but densely filled, as was that viscus, with finely granular matter. The rounded termination, marking doubtless the position of the cloaca, is on the descent of the back, some distance in front of the foot-fork.

I was not able to discern any internal organs besides the alimentary canal, though the opacity caused by the hairs was much less than usual. The anterior half of the body shows the bases of the hairs, like very delicate dots set in quincunx. The sides and back are armed with fine bristles curving backwards. The points of the foot-fork are slender, sub-cylindrical, and slightly dilated at the lips, which are decurved.

The animal crawls impatiently about, apparently seeking for food; for I several times saw it eagerly snap at a Monad, that roamed near, opening the mouth at the same moment. Once I believe I saw it seize and swallow the prey, though as it was the work of an instant, I could not be quite certain. I have obtained but one specimen of this species.

Genus III.—DASYDYTES (Gosse).

Head distinct: posterior extremely simple, truncate; body furnished with hair.

Sp. 8. *D. goniathrix* (Gosse). (Pl. ii. Figs. 9—12.) Hairs long, each hair bent with an abrupt angle; neck much constricted.

This and the following species I briefly defined, and formed of them the genus *Dasydites*, in the *Annals of Natural History*, for Sept. 1851. The present very remarkable form was obtained from a pool at Leamington, in July of the preceding year. The length of the body is 1-150th of an inch; measured to the tips of the bristles, 1-110th. The head is nearly circular, as wide as the body, without lobes, but abruptly separated from a slender neck. The mouth takes the form of a *permanently* projecting truncate lip, or short tube. The body is rather slender, swelling toward the hinder part, and tapering to a rounded or truncate point, without any trace of the ordinary forked foot. A most peculiar and bizarre character is imparted to the creature by its clothing of very long bristles, set along each side of the back, pointing obliquely backward, but apparently wanting along the mesial line, which rises into a ridge. Each bristle is bent near its tip at an abrupt angle (see Fig. 12), so that it looks as if it had been broken and mended. The front of the head is furnished with long delicate hairs, not geniculate, which form two pencils directed backward, one falling on each side. Strong and conspicuous vortical currents were produced on each side of the head, like those of the true Rotifera (Fig. 9), and in one specimen I distinctly saw that they were caused by these frontal pencils of hairs, and that these were very long vibratory cilia. The ventral surface is set with short fine hair, which becomes longer behind (Fig. 10); doubtless cilia of unusual development, for they produced strong longitudinal backward currents, continued from the frontal vortices.

The tube of the œsophagus is always distinct, but the walls are to be discerned only when the animal is flattened by the compressorium. Then it is seen to be fusiform, instead of cylindrical, extending through one-third of the body, where its tube enters a wide cylindrical intestine, with a broad abruptly truncate anterior extremity; of this a short portion is clear, when the remainder is occupied with opaque granular food, and possibly may represent a pancreatic gland of abnormal form, as it embraces the hinder part of the gullet tube, or else is perforate with a similar tube (see Fig. 9). But in one specimen this very portion was intensely opaque, while the intestine was granular. The cloacal orifice seems to be at the very extremity of the body, as no termination of the intestine, nor even any diminution of its diameter, can be discerned short of that point. On repeated occasions I have seen the act of defecation, in one of which an oval clear corpuscle was dis-

charged, which, before, as it lay near the extremity of the body, had much puzzled me; it was probably the undissolved envelope of a minute animalcule, which had been devoured.

In one specimen, a large very clear viscus of irregular form occupied the widest part of the body, above the intestine, elevating the back into a hump. After some hours this viscus, which at first appeared structureless, developed an egg-cell with its nucleus, thus proving to be the ovary. The entire animal is of a pale smoky colour. It does not crawl like the *Chætonotes*, but habitually swims swiftly about, keeping, however, near the bottom of the water.

Fig. 11 represents an individual as it appeared after it had become sluggish, and apparently dying; it is evidently a view lengthwise along the back, the lower part, or that next the observer, being, I believe, the head. It is valuable as showing the arrangement of the angled hairs.

Sp. 9. *D. antenniger* (Gosse). (Pl. ii. Figs. 13, 14.) Hairs short, downy; a pencil of long hairs at each angle of the posterior extremity; head furnished with two club-shaped organs resembling antennæ. The horse-pond on Hampstead Heath yielded me this species, in August, 1850. It is a little smaller than the preceding, the length being only 1-170th of an inch; but measured to the tips of the hairs, 1-140th. In general figure, and in some particulars of its organization, it appears to diverge less from *Chætonotus*, than the preceding species does. The head is round, as wide as the body; and there is but little constriction at the neck. The upper surface is covered with short but dense hair pointing backwards, and apparently set in quincunx; the posterior extremity is somewhat three-lobed, the middle lobe furnished with a terminal brush of diverging hairs, the outer lobes each bearing a pencil of much longer hairs proceeding from its exterior side, and approaching or crossing the opposite pencil at the tips (Fig. 14). From the front of the head projects the prominent tubular mouth; on each side of which long hairs fall backward as in *D. goniathrix*, and these, by their vibration, cause a perfect vortex on each side (see Fig. 13), while there is an accessory current also down along the side, and probably all along the belly. But the most remarkable feature in this species is the presence of a pair of antennæ or tentacles; these are nearly as long as the width of the body, are slightly clubbed, and are placed one on each side of the tubular mouth, whence they spring in a curve forwards and outwards. Near the middle of the head is a little rounded mass, somewhat curdled in appearance, which I take to be a cerebral ganglion. An unusually wide and long œsophagus, ventricose behind and permeated by a tube through its centre, leads from the mouth

to a nearly cylindrical intestine. This widens a little in front to embrace the bulbous end of the œsophagus, and extends nearly to the posterior extremity. It was filled with food of a rich uniform green hue, and contained many air-bubbles, especially towards its fore part. On each side of the fore part of this viscus, I could indistinctly trace a lengthened slender body, apparently a tortuous vessel, which on one side seemed to be connected with a small oval clear organ. From the fact that sometimes it was quite plain, while at others I could not discern any trace of it, it may probably have been a contractile vesicle. The whole outline of the animal appeared to have a wavy or notched character, indicating a tuberculous surface, as in *C. Slackie*, if it was not an optical illusion, and caused by the hairs.

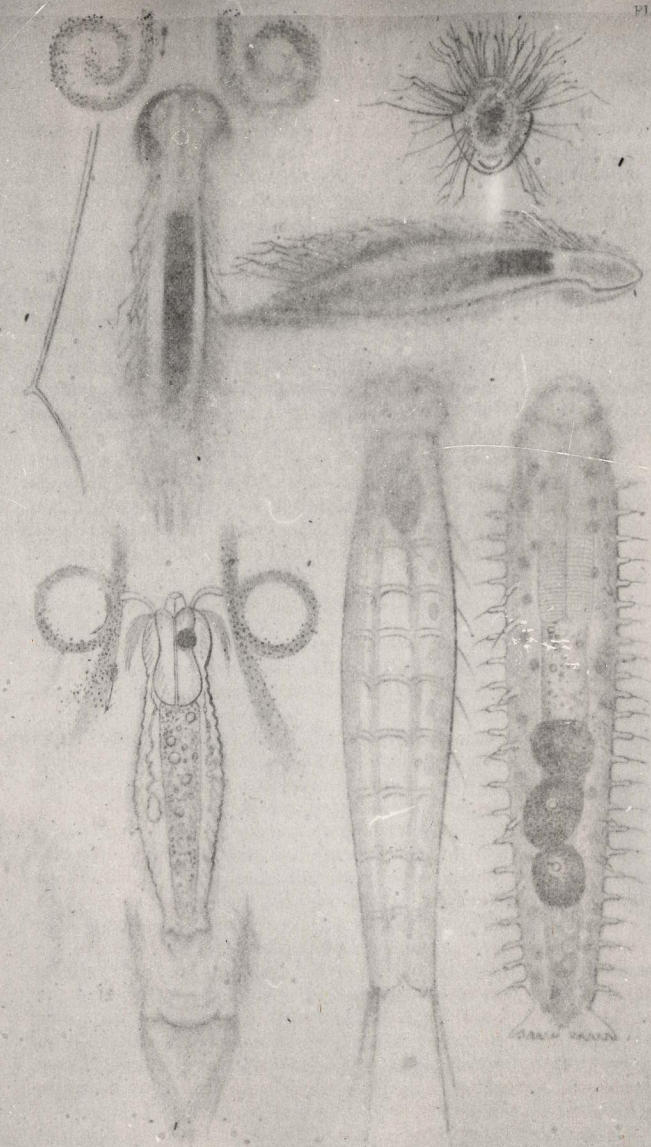
This little animal was very active, swimming with much rapidity, and rarely becoming still; when confined in cells formed by wool-fibres it was most persevering and often successful in forcing the barriers, by getting its thin flat head under a fibre, and pushing until it forced its body through also.

Genus IV.—TURBANELLA (*Schulze*).

Head distinct, surrounded by a ring of cilia; body naked above, clothed with cilia beneath; two rows of bristled processes along each side; posterior extremity a broad flat plate with a central division.

Sp. 10. *T. hyalina* (*Schulze*). (Pl. ii. Fig. 15.) Length 1-60th to 1-48th of an inch; width 1-480th to 1-360th. The body is lengthened, somewhat flat, transparent, colourless; separated by a strangulation from a rondo-triangular head, which is wholly covered with fine cilia, and bears besides a wreath of strong cilia around its centre. The hinder extremity expands into two hard flat plates, which are indented comb-like on their edge, and are divided in the middle by a sinus, into which opens the cloaca. At nearly regular distances, all along each side of the body, are placed stiff processes of the skin, to the number of twenty to twenty-five, projecting at right angles horizontally; and above these another row, consisting of six or eight similar processes, inclined backward, making from fifty to seventy in the four rows. Each process bears at its tip an excessively fine immoveable seta of about its own length. These processes as well as the skin itself were found to be quite soluble in potass, and therefore are not composed of chitine.

The alimentary canal runs in a straight line through the whole length. The mouth, opening on the rounded front of the head, and surrounded by a finely-plaited and indented edge, leads into the usual œsophagus with very thick transparent



P. H. Gosse, del. & sculp.

HAIRY-BACKED ANIMALCULES Chaetocetes.

- 9, *Dactylo gonatharia*, viewed from above; 10, viewed from the right side; 11, viewed from the front; 12, one of the bristles greatly magnified; 13, *D. antenniger*; 14, the caudal pencils more highly magnified. 15, *Turbanella hyalina*, (after Schulze). 16, *Echinodera Dujardini*, (after Dujardin).
N.B.—All the figs., except 9, 13, and 14, are magnified 300 diam., and all, except 15 and 16, are from the life.

muscular walls, which terminates at about one-fourth of the body-length. The perforation is so slender as to be detected only while a morsel is in the act of being swallowed. The intestine presents nothing remarkable, except that in its yellowish granular wall containing fat-cells, Dr. Schulze thinks he finds a hepatic function. The body-cavity is occupied by a finely-granular, soft parenchyma, the corpuscles scattered in which are not driven to and fro by the movement of the body, in which therefore a somewhat firm consistence is inferred. No trace of a muscular, nervous, or vascular system was discovered, though many individuals were carefully examined.

The animal is hermaphrodite. A great ovary lies in the posterior half of the body, over the intestine, in the hinder portion of which are contained the incipient egg-germs, consisting of vesicle and speck, which are developed in the anterior portion, becoming surrounded with a granular yolk. Generally one or two eggs are found freed from the ovary, enclosed in a special soft colourless envelope. In front of these mature ova lies the spermatid gland, a mulberry-like mass of cells, and close to it two groups of spermatozoid germ-cells, apparently unenclosed, lying free in the parenchyma. In some examples the spermatozooids were developed, but showed no spontaneous motion.

The specimens described occurred to Dr. Max Schulze in sea-sand from Cuxhaven, with *Desmidiæ* and *Diatomaceæ*. They swam with a gentle gliding movement, like the *Turbellaria*.

Genus V.—ECHINODERA (Dujardin).

Body articulated; set with few bristles; head distinct; posterior extremity truncate, with two short processes, and spines.

Sp. 11. E. Dujardini (Gosse). (Pl. ii. Fig. 16.) As the discoverer and describer has not assigned any specific name to his animal, I take the liberty of honouring it with his own. M. Dujardin obtained the form in July, 1841, in sea-water from St. Malo, which had been kept for six months. The generic name, signifying "spinous neck," he selected to show its relations with *Echinorhynchus*. The body, 0.30 mm. to 0.55 mm. (about 1-75th to 1-50th of an inch) long, is oblong, almost cylindrical in front, a little flattened behind, where it terminates by two great bristles, accompanied by two other bristles of smaller size, like those we see at the extremity of the *Cyclopidae*. The body is composed of ten segments, without counting the head, which is retractile, bristled with long and flexible spines, and without counting the caudal laminae (*lames*) which accompany the terminal setae, making the total number of seg-

ments twelve. The first segment of the body is united to the second by a simple intersection; all the rest are separated by a horny arch very distinct, presenting three articulations on the plane or ventral face, viz., one answering to the axis, and two lateral, between the edge and the middle. Each segment encloses the next, and appears laterally armed with two points or spines imbedded in the rear. It is covered, or simply bordered with cilia, extremely fine, not vibratile, and very difficult to perceive.

Under the first or the second segment, according to the state of retraction of the trunk, we perceive in the interior two red oculiform specks, which pertain to the retractile and protractile portion of the digestive apparatus. To the extremity of this retractile portion extends the œsophagus, longitudinally plaited in the interior, and furnished in front with a coronet of lobes, or teeth, which represent the mouth. The membranous and plaited tube of the œsophagus is covered by a thick muscular layer (*couche*), forming a cylinder 0.035 mm. wide, and 0.092 mm. long, which occupies the 3rd, 4th, and 5th segments of the body, and which, swollen in the middle, takes the form of the pharyngeal bulb of some worms. The stomach, which succeeds, is cylindrical, 0.040 mm. wide, 0.17 mm. long, and contracts itself from the front backward by successive waves: it is invested with a brownish floccose layer, which appears to represent a liver. Finally, a slenderer portion of the intestine occupies the tenth segment, and terminates between the two caudal plates.

M. Dujardin has since found it, on repeated occasions, in sea-water, on oyster shells, etc., always with the same form and characters, without ova or genital organs. "If I had not seen it," he remarks, "always alike in vessels preserved more than a year, I might have supposed it the larva of some animal that had escaped my researches. Incomplete, however, as are my observations, after having vainly sought to add to them through ten years, I believe that they suffice to show a type differing from those of the Helminthes acanthocéphales, the Systolides or Rotifera, the Entomostraca Copepoda, and the Sipuncles, and at the same time offering points of resemblance to each of these. It is a sort of Copepode, without feet, with the mouth of a Sipunculus, and the neck of a Echinorhynchus, and a muscular œsophagus like those of the Systolides (Rotifera), the Tardigrades, and the Nematoid Helminthes."

Genus VI.—TAPHROCAMPA (Gosse).

Body articulate, destitute of hair; posterior extremity forked; mouth a mastax, with mallei and incus, which are incurved.

Sp. 12. *T. annulosa* (Gosse). (Pl. i. Figs. 17—19.) This species and genus I defined in the *Annals of Nat. Hist.* for Sept. 1851, collocating it with the *Notommata* and *Furculariæ*, but indicating its relations with *Chaetonotus*. It occurred to my researches in a pool near Leamington, in July, 1850. Its length is about 1-110th of an inch. The form is very larva-like; the body is sub-cylindrical or fusiform, terminating in a bifid foot; it consists of many rings or segments, which are set within the clear cylindrical integument, and are themselves of a sub-square form, with projecting angles. Thus a transverse segment would present the appearance of Fig. 19;—a structure not easily explained. I could see no appearance of vortices, nor even the vibration of cilia; yet the form of the mastax is Rotiferous, and appears closely to resemble that of *Furcularia gracilis* and of the *Monocerca*, consisting of an incus, with a long fulcrum and a pair of long incurved mallei. The animal can bring the tips of the jaws to the front, and nibbles extraneous matters with them like the *Notommata*, etc. A long, wide, straight, cylindrical alimentary canal, without any accessory glands or constriction, leads from the mastax to the cloaca just above the forked foot. It was in this specimen nearly empty, slightly tinged with yellow. All the rest of the animal was colourless. No eggs or ovary were visible. At the occiput, behind the mastax, was an opaque mass, which was white by reflected light, but showed no redness or appearance of eye, by either reflected or transmitted light. Like the cerebral ganglion in many *Notommata*, it lay at the bottom of a wide deep sac (Fig. 18). The animal contracts strongly and continually like *Notommata*; but the sphere of the contraction is the space occupied by the alimentary canal, the parts outside the boundary lines of this remaining still, while the parts within retract forcibly, and both ways, but chiefly from behind forwards. In its movements it resembles *Chaetonotus*, crawling sluggishly about the glass and the particles of sediment. I never saw it attempt to swim.

The number of genera has thus been increased, since Dr. Schulze wrote his summary of the family, from four to six, and of species from seven to twelve. With these augmented materials it seems to me that the judgment expressed by him as to their affinities must be somewhat modified, and I have no hesitation in recurring to the original decision of Ehrenberg, and in placing the *Chaetonotidae* among the ROTIFERA. Tortuous canals and a contractile vesicle I have seen in *C. larus*, *C. Slackiæ*, and *Das. antenniger*: pancreatic (?) glands in *C. Slackiæ*; ciliary vortices are made by *D. goniathrix* and *D. antenniger*, not to be distinguished from those made by many ROTIFERA, as *Furcularia*, *Notommata*, etc. The egg-develop-

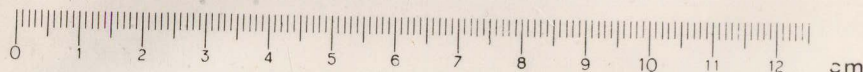
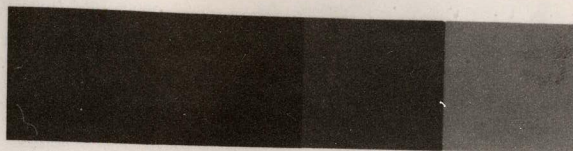
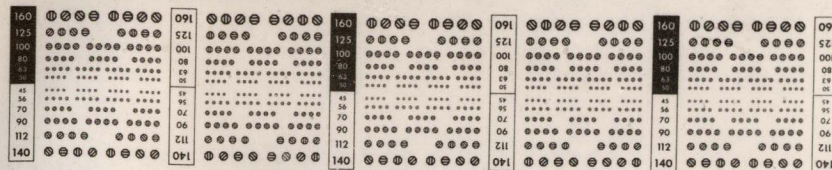
ment, the great size of the egg, and its chitinous shell, are decidedly Rotiferous.* A great cerebral ganglion, exactly corresponding to that of *Notommata aurita*, *N. tripus*, and others, is found in *Taphrocampa*, and indistinctly in *D. antenniger*. The mastax, so eminently characteristic of ROTIFERA, is fully developed in *Taphrocampa*, where, however, the form and extent of the alimentary canal are as in *Chaetonotus*. The furcate posterior extremity is not a tail but a foot, as in ROTIFERA, the cloaca opening on its dorsal side; it is not indeed separately moveable even in *Taphrocampa*, yet its homology with the foot of *Notommata* cannot be overlooked; it is wanting in *Turbanella*, *Echinodera*, and *Dasydytes*; so it is in those true ROTIFERA, *Asplanchna* and *Anuraea*. The very long attenuate hairs that radiate from the face in several (perhaps in all) of the *Chaetonoti*, which have a singular power of independent vibration, recal the very similar vibratile setae of *Floscularia* and *Stephanoceros*; and possibly the little hooked organs which I find on the front of *C. maximus*, and the club-shaped horns of *D. antenniger*, may have a parallel in the frontal hooks of *Melicerata*.

In short, if *Taphrocampa* has a true affinity with *Chaetonotus*, there can be no question that the family belongs to the ROTIFERA. It is true there are important diversities between these genera, but there are forms which bridge the hiatus. *Echinodera* seems to approach closely to *Taphrocampa*, but *Echinodera* has much in common with *Dasydytes*. *Turbanella* is very peculiar, yet I doubt not Schulze is right in allying it with *Chaetonotus*. It is, doubtless, a group whose members manifest great diversity; but probably there remain many forms to be discovered which will further facilitate transition from one to another, and illustrate its exterior relations.

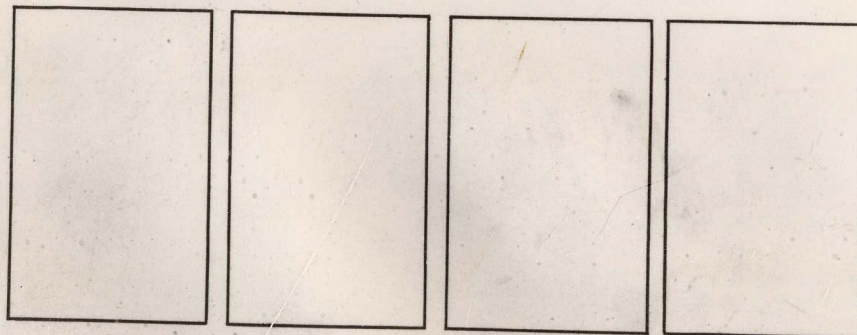
In the cilia-ring on the head of *Turbanella* in its curious setiferous lateral processes, in the form of its head, in the annulation of *Echinodera* and *Taphrocampa*, and in the long hairs of *Dasydytes*, especially the terminal tufts of *D. antenniger*,† there seem to be some strong points of alliance with ANNELIDA, and I am inclined to place the family on the border-ground between these two great classes, the ROTIFERA and the ANNELIDA, with a preponderance of characters belonging to the former.

* The relative position of the reproductive and the digestive organs is, however, contrary to that which obtains in the ROTIFERA; in which the latter are dorsal the former ventral.

† I beg to refer, for descriptions and figures of the young forms of some marine Annelida, to my *Tenby*, p. 279, and Pl. xv.



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